Radio, Electronics and Communications

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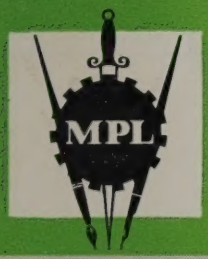

In This Issue . . .

- V.H.F. Aerials — Part II
- A Transistorised Hi-Fi Tuner
- Signal Generators
- Wellington Trade Fair
- Transistors Switching Inductive Loads
- Communications Satellite Systems

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 19 NUMBER 8

OCTOBER 1, 1964

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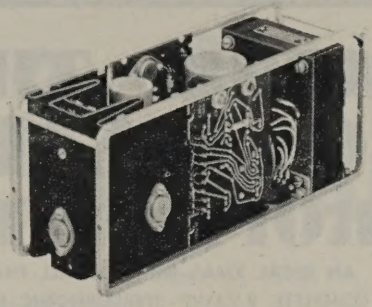

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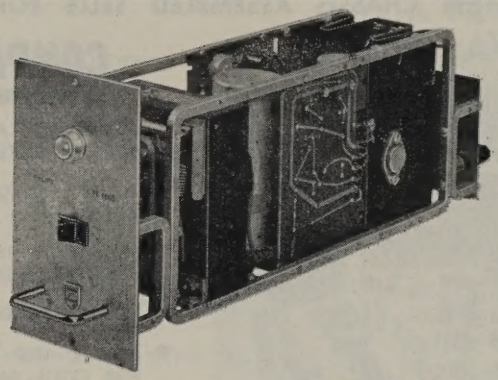

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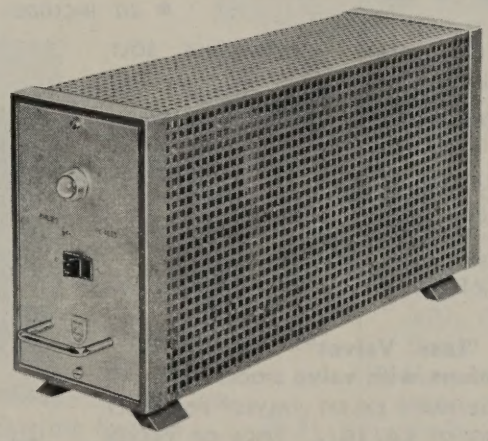

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PE 4882	150/200/250	30 - 130 mA	0.1	12	5
PE 4883	150/300	0 - 200 mA	0.1	1	3
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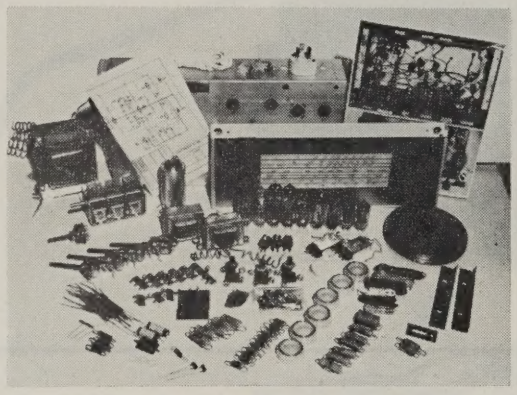

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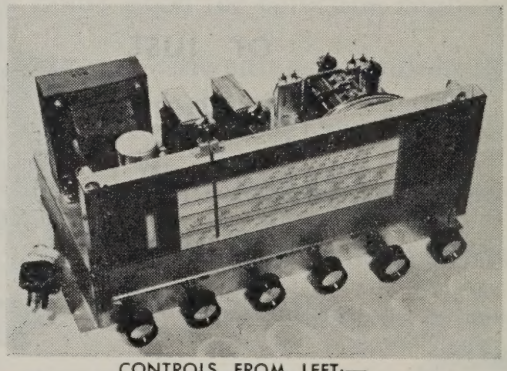

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On Our Cover

A NEW ZEALAND EXPORT BY AWA

Amalgamated Wireless (Australasia) N.Z. Limited has had a number of export successes in the past two years involving exports from the company's New Zealand Engineering Products factory to Fiji, Tonga, Samoa and New Guinea. The company has now secured a valuable export order for Marine Radiotelephone Equipment.

Following satisfactory tests on the new Teleradio 65, Australia's giant electronic manufacturer—AWA—has placed an order on the New Zealand subsidiary company for 50 equipments.

The Teleradio 65, illustrated, is one of a new generation of "Type Approved" transistorized Radiotelephones developed in New Zealand by AWA to comply with the New Zealand Shipping Radio Rules. A key factor in the extensive success of this equipment is the economic battery drain, achieved through the extensive use of transistors.

Negotiations for further such exports are now being conducted by AWA with her overseas associates.

FEATURED NEXT MONTH . . .

5" TV Set — Part I of a Three-part Feature
Microelectronics
"3 & R" Mantel Receiver
Magnetic Tape Data Recording — Part I
New Zealand's Frequency Standard

Also . . .

Book Reviews
New Products
Serviceman's Column

Compare for yourself: Select the performance you need—check the price, adding one vertical plug-in and one horizontal to the $1325 price of the 175A main frame.

Vertical plug-in	Performance	Price
1750B Dual-Trace Amplifier	50 mc bandwidth (7 nsec rise time), 50 mv/cm max sensitivity (each channel), B channel out available for trigger	$325
1751A Single-Channel Amplifier	Low-cost performance: sensitivity 50 mv/cm to 20 v/cm, dc to 50 mc (7 nsec rise time)	$160
1752A Differential Amplifier	5 mv/cm to 20 v/cm sensitivity; dc to 18 mc bandwidth at 5 mv/cm; differential input with 40 db common mode rejection on four most sensitive ranges	$225
1752B High Gain Amplifier	5 mv/cm to 20 v/cm; dc to 30 mc at 5 mv/cm; 40 mc at 50 mv/cm; differential input on all ranges	$285
1754A Four-Channel Amplifier*	40 mc bandwidth, sensitivity 50 mv/cm to 20 v/cm; triggering possible from any of the 4 channels; 9 nsec rise time, ideal for computer logic applications	$595
1755A Dual-Channel High-Performance Amplifier*	1 mv/cm sensitivity with 20 mc bandwidth, 50 mc bandwidth at 10 mv/cm and above, dc coupled; B channel available for trigger	$575
Horizontal plug-in	**Performance**	**Price**
1780A Auxiliary Plug-in	Allows standard functions of scope, 10 nsec/cm to 5 sec/cm sweep; normal or single sweeps	$25
1781B Sweep Delay Generator	Permits detailed analysis of complex signals or pulses; 0.5 μsec to 10 sec delay; mixed sweep for simultaneous picture of total and expanded portion of signal; jitter less than 1 part in 50,000	$325
1782A Display Scanner*	Permits recordings on external x-y recorder of waveforms displayed on crt	$425
1783A Time Mark Generator*	Provides synchronized intensity-modulated markers, 10, 1 and 0.1 μsec, ±0.5% accuracy, for simplifying rise time and pulse duration measurement	$130
1784A Recorder*	Pushbutton strip-chart recording of repetitive traces on crt, complete with graticule marks; 1/20th the price of a photograph; recording paper 5 cm (6 graticule divisions) approximately same size as photo	$775

*Features available only with the hp 175A, regardless of cost

comparison proves

no scope beats the hp 175A for your requirements: performance versatility — value!

With its six vertical plug-ins, five horizontal plug-ins and high-capability basic main frame, no oscilloscope available today gives you better performance for your money than the Hewlett-Packard 175A 50 MC Scope. The 175A main frame, $1325, permits bandwidth to 50 mc and offers dual plug-in capability that permits unprecedented versatility. Look at these unique plug-in features: The 1784A Recorder plug-in permits permanent records of waveforms, simply and at a fraction of the cost of a photograph. Other horizontal plug-ins include a scanner for large trace recordings on an external recorder, sweep-delay operation, and time markers.

A wide selection of vertical plug-ins assures complete measurement coverage. The new 1755A, for example, features dual-channel sensitivity of 1 mv/cm at 20 mc bandwidth and 10 mv/cm at 50 mc. Even on the four-channel plug-in the bandwidth is 40 mc.

Once you've acquired the main frame, the flexibility and value of the 175A are yours. Compare plug-in capabilities and compare price-for-performance. Compare the number of scopes you need to do all the jobs done as well by the 175A. Then call your hp field engineer for a demonstration; or write for complete technical data.

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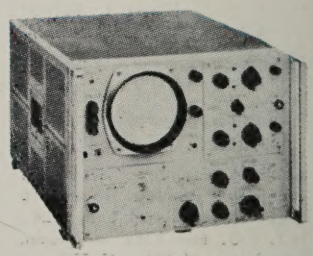
Prices f.o.b. factory.
* Equivalent N.Z. prices available on application.



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Letters from Readers . . .

Sir,

Enclosed is a year's subscription for the magazine Radio, Electronics and Communications.

In addition I am interested in purchasing all the back copies of this publication which include circuit diagrams and basic servicing instructions of currently produced commercial radio and TV appliances. I have included a further £2 to cover this cost.

Will you please debit or credit my yearly subscription with the balance and advise me.

C. J. MACKEY,
Papakura.

We thank you for your interest in our feature and have done as you requested.
—Ed.

Sir,

Could you let me know which issues of your magazine contained a series ot articles on Domestic Stereo Systems.

Also if available, and the complete cost including postage.

L. J. RYAN,
Queenstown.

The series on Domestic Stereo appeared in May 1962, June 1962, July 1962, September 1962, November 1962. The cost of these would be 11/3 post free.
—Ed.

Sir,

re Technical Instrument Article July 1st, 1963 issue, page 15.

I would be very much obliged if you could confirm for me the values of the condensors shown in the schemetic Fig. 4.

Does 10, 5K, 7.5, etc., refer to values in picafarade?

G. C. ROCKLEY,
Auckland.

Thank you for your letter. The values you refer to are in picafarads.
—Ed.

Sir,

It has been noted in recent editions of your publication reference to books suitable for the shortwave listener, in particular the World Radio Handbook, and an address in London has been given for copies.

I have been agent in this country for the World Radio Handbook and other publications since the first edition in 1948, and carry stocks of the main books.

The World Radio Handbook, 1964 edition, a few copies are left in stock price 20/6 posted, How to Listen to the World is 14/6 posted, and Medium Wave Guide 12/6 posted. Reference to the enclosed brochure will give you fuller details on these books.

It is regretted that your shortwave page recently came to an end, as the increasing interest in this field of information in the magazine form is shown by the increase in scope of my pages in Radio, Television and Hobbies in Sydney, in the New Zealand Listener, and the commencement this year of a 15-minute programme over Radio New Zealand for the shortwave listener, Arthur Cushen's DX World. It is hoped the news in your pages on the subject of listening will soon be reinstated, but not being a regular reader of your magazine, being blind, I depend on contact with other interested readers you have, for details on the progress of your publication.

ARTHUR T. CUSHEN,
Invercargill.

We thank you for your letter and are sure the information therein will be of interest to our readers. On the subject of our shortwave page we, too, are sorry that it has lapsed. We are very interested in obtaining a replacement correspondent and would appreciate hearing from anyone interested.
—Ed.

ENQUIRY CARD AD. 18

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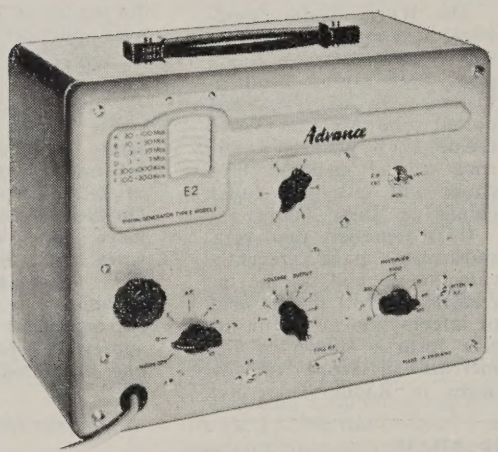
ENQUIRY CARD AD. 6

Advance r.f. signal generators

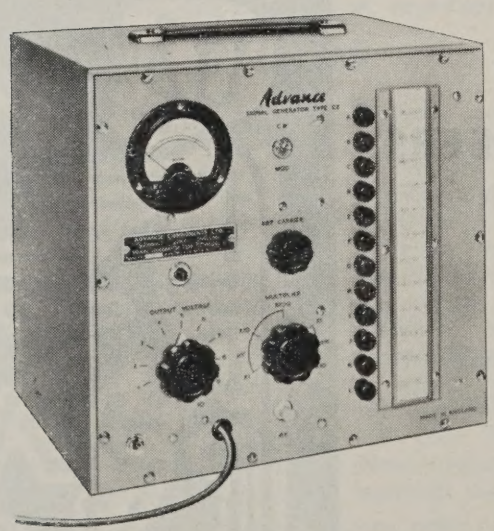


E2

R.F. Signal Generator

Frequency range 100kc/s to 100Mc/s in six bands. *Calibration accuracy* ±1%. *Output* Approximately 1V at the full R.F. socket. Continuously variable 1μV to 100mV. Accuracy of maximum output ±3dB. Accuracy of step attenuator ±(3dB + 3μV). *Output impedance* 75Ω unterminated. Normally this is matched with a 75Ω terminating pad TP1B, providing 37Ω, 10Ω and a standard 10Ω dummy aerial. *Modulation* INTERNAL 30% ±5% at 400c/s ±10%. EXTERNAL 0 to 80%, 10c/s to 4kc/s; 0 to 40% at 10kc/s. *A.F. output* 0 to 50V, 400c/s into high impedance. *Leakage* Less than 3μV. *Power requirements* 105 to 125V and 210 to 250V, 40 to 100c/s, 20W.

Dimensions 13in (33cm) wide × 10¼in (26cm) high × 8in (20·3cm) deep.
Weight 17½lb (8kg).



C2H

R.F. Signal Generator

Frequency range Twelve spot frequencies in the range 30kc/s to 40Mc/s. *Output* Continuously variable 1μV to 100mV. *Accuracy* Below 10Mc/s, ±1dB ±1μV; 10 to 40Mc/s, ±2dB ±2μV. *R.F. level* The R.F. level between push-button settings does not vary by more than ±3%. With ±10% a.c. supply variation, the output level change will not exceed ±3%. *Output impedance* 75Ω unterminated. *Modulation* Carrier internally amplitude modulated 30% ±5% at 400c/s ±5%. *Power requirements* 100, 210, 230, 250V, 40 to 100c/s, 25W. *Dimensions* 12¼in (31cm) wide × 13¼in (33·7cm) high × 10in (25·4cm) deep. *Weight* 28lb (12·7kg).

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PAST AND PRESENT

As this Editorial is being written, many of our readers will be listening to or watching commentaries on the Olympic Games currently being held in Tokyo. By means of the most modern techniques in communications, the viewing public in the U.S.A. and other European countries will be able to watch direct telecasts of the events via "Syncom 3," and radio listeners in Australasia will hear direct broadcasts from the various centres with the utmost clarity by medium of the "Compac" cable.

Whilst hailing these achievements let us pause briefly and allow our thoughts to travel back in time almost exactly 40 years, to the days of the birth of Transoceanic communications between New Zealand, and the United States, Britain and many other Northern Hemisphere countries.

During 1923 a small band of amateurs in the U.S.A., England and Europe had succeeded in linking four continents by means of their techniques, created a reliable Europe-U.S.A. traffic route, and established communications over a distance of 6000 miles or so. In carrying out these experiments, the amateurs were covering much greater distances than the large commercial stations running hundreds of times more power and with vast aerial systems. This was due solely to the use by the amateurs of the "short waves" as the frequencies were then called. Amateurs throughout the world had been virtually forced into the position of using the then considered "useless" wavelengths below 200 metres.

On 21st September, 1924, the first two-way amateur communication was established between the United States and New Zealand when ⌀6BCP of San Pedro, California, contacted z4AA, the station owned and operated by Frank Bell, who lives at Waihemo, Otago. Here was a World Record — communication over a distance of 6,900 miles. By October 10th, amateurs in many parts of the United States had worked across to New Zealand. The crowning achievement in this respect was by ⌀1SF of Short Beach, Connecticut, who contacted z4AA on October 13th and these two held the world's distance record for six days with a figure of 9,000 miles.

But six days was a long time for a world record to stand under those conditions. On October 19th, 1924, all amateur distance records were broken and the practical limit of terrestial distance was reached when the antipodes were linked by amateur radio. Again it was Frank Bell z4AA, the New Zealander, who participated in so much of the outstanding early work, on that day maintained communication with g2SZ, the station operated at the Mill Hill School, in London, for an hour and a half. The distance, in the neighbourhood of 11,900 miles, closely approached half of 24,860 miles being the circumference of the earth.

These few short weeks saw the end of one, and the beginning of a new era. They marked the emergence of the Short Waves as the revolutionary method for long distance communication using only relatively low transmitter power.

In order to commemorate Frank Bell's achievements, a Plaque is being unveiled at a ceremony on the afternoon of Sunday, 18th October, at Frank Bell's residence, Shag Valley Station, Waihemo, Otago. In this way these epoch-making achievements, in which New Zealanders led the world, firmly establishing the superiority of the short waves for long distance transmission will be preserved to be recognised by future generations of amateurs, who themselves could be responsible for further memorable technical achievements.

— I.H.S.

A TRANSISTORISED "HI-FI" TUNER

by Irving Spackman, ZL1MO

This article was written in response to a number of enquiries from our readers for a simple tuner to provide good quality reproduction through a hi-fi amplifier, from the local broadcast stations. Previous experience with A.C. powered tuners of various kinds in many cases gave considerable trouble with "hum loops" produced by two A.C. operated pieces of equipment being connected together. Small A.C. currents tend to flow between the tuner and amplifier, and these currents can induce unwanted hum into any cables carrying the audio programme at low signal level.

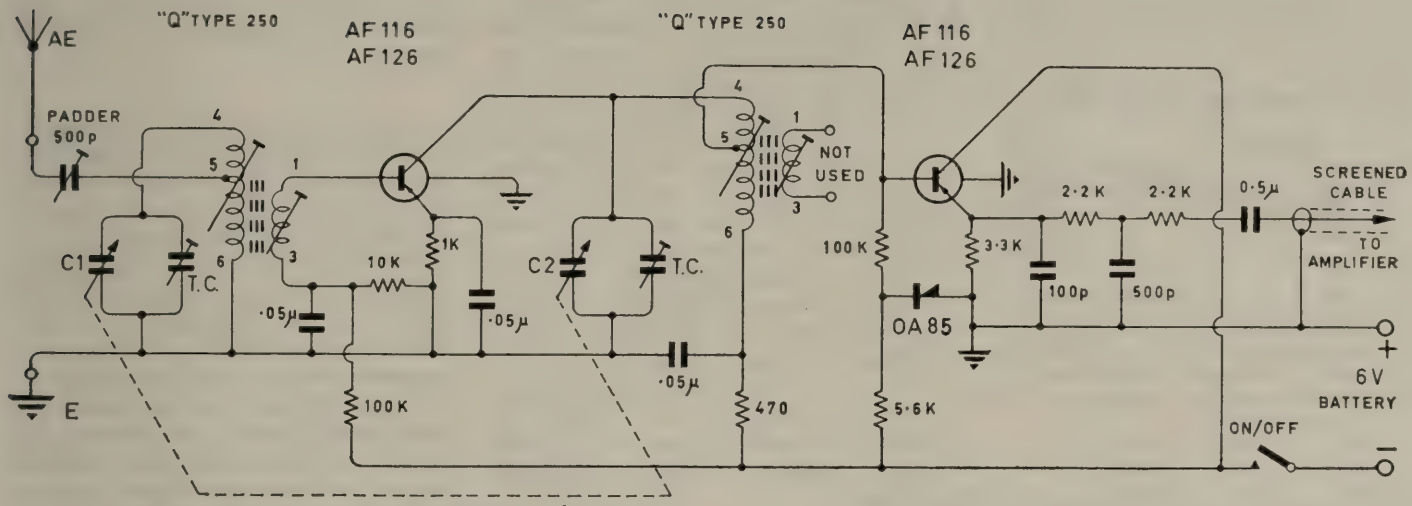
In preparation for this article, the author tried out several simple "crystal tuner" circuits, with only indifferent results. When operated at a distance of 10 miles or more from the local station, these tuners needed a fairly large antenna and a good earth connection to provide sufficient signal level to feed the radio input of the average type of "Hi-Fi" amplifier. Under such conditions the poor selectivity was apparent if two of the desired stations were located fairly close together in terms of frequency. When a simple crystal type tuner, even if it utilised two tuned circuits, is used in close proximity to the transmitting stations, there is little chance that the various stations can be separated sufficiently to give good reproduction from any one.

The author has used a simple T.R.F. type receiver as a spare house receiver for several years. This receiver, called the "Triplex," and which was described in February and March 1962 issues of this journal, utilised an R.F. stage with two tuned circuits; a diode detector and two stages of audio. This little set produced excellent quality and yet shows sufficient selectivity to separate the four main Auckland stations at a distance of only a few miles. In addition, the gain of the receiver is sufficient to enable the use of three feet of wire or a ferrite loop for the necessary antenna.

It was decided to duplicate the R.F. and detector end of the "Triplex" if possible using transistors. This would enable the Tuner to be self-powered, and therefore the only connecting lead needed between the tuner and hi-fi amplifier is the shielded cable carrying the audio programme. The current demand from a small 6 or 9 volt transistor battery is only a couple of milliamperes so that the battery will last very close to its normal shelf life.

Let us now look at the circuit. The antenna is connected to the tap on the aerial coil through a 150 or 500 pf. padder type compression capacitor, which is used to control the loading of a long antenna on the 1st coil. If only a short antenna is contemplated, then this series capacity can be removed from the circuit. The primary requirement is to keep the "loaded Q" of the coils high to secure the maximum selectivity. The first transistor will produce high gain over the broadcast frequency range. The collector of this transistor is connected across the full winding of the interstage coil because of the high output impedance of the AF116 operating at these frequencies does not cause any serious loading on the collector tuned circuit. The tapping on the coil is capacitively coupled to the base of the second AF116 which operates as a Class B emitter-follower detector. The intrinsic base-emitter voltage drop of this emitter-follower is overcome by providing a small amount of bias from that developed across a conducting OA85 germanium diode. This technique also helps to compensate for any change in the base-emitter voltage drop with changes in ambient temperature.

A few words now perhaps should be spent on the consideration of the tuning gang for this tuner. Either a 365 or 420 pf. per section 2 gang condenser should be used. If a 365 pf. type is used, the full coverage of the broadcast band may be difficult to achieve. Do not consider the use of two gang condensers designed for transistor radios, as the variation of capacitance of the two sections is markedly different. One section tunes the antenna circuit, but the oscillator section covers a smaller percentage frequency range and therefore needs a smaller maximum capacitance. If the condenser gang chosen does not have small trimmers across each section, then these two small trimmers will have to be connected externally to the gang, and this could well be done by soldering the trimmers directly across the coils. Either Philips 3-30 pf. or ceramic or compression types are suitable. By the use of the iron dust slugs and the trimmer capacitors good



SIMPLE SENSITIVE BROADCAST BAND HIGH-FIDELITY TUNER.

frequency tracking, which is essential to the best performance of this tuner can be assured.

Use good quality resistors, preferably of the high stability type and ceramic, silver mica or polyester type capacities. Most of the wiring can be easily carried out by mounting the components on one or two tag strips mounted adjacent to each coil. Be careful when soldering the transistors into circuit—hold each lead which should not be cut shorter than ½ inch from the base of the transistor case, with a pair of thin nosed pliers, whilst soldering the connections. There are four connections to the AF116 series of transistors. The collector lead is spaced from the other three. Of these, the lead nearest the collector is an earth shield connection, the next is the base, whilst the emitter lead is on the outside of the other two.

The tuner can be constructed in several ways. Perhaps the easiest for the home constructor is to use a small baseboard of 5-ply with a front panel of 3-ply or hardboard. Make a box or U-shaped cover to fit over the top, keeping in mind the size of the batteries. If plywood is used, it can be stained or varnished or painted to suit the individual tastes. Two small Z-shaped metal brackets can be fabricated out of aluminium and the coils can be mounted on these to support them above the base board. A simple aluminium clip can also be fabricated to hold down the battery. Depending on the type of condenser gang purchased, this may either be supported from the front panel or by suitable brackets screwed on to the front and rear of the condenser gang frame. Do not forget to connect the moving plate wiper connecting lugs back to the earth line associated with the coils and transistors. If a metal cabinet is desired, then one of the small instrument cabinets manufactured by Fry-Co Products Ltd. would be suitable. These are 9 inches wide, 6¾ inches high and 5½ inches deep and are finished in grey stoved hammertone enamel. A small chassis is included on which the tuner can be constructed; whilst the front panel is of sufficient size to carry a dial and escutcheon without difficulty.

Before connecting the batteries and switching on, make sure that all the components are correctly wired. Note particularly that the collectors of the transistors return via the coils and associated decoupling resistors to the **Negative** side of the battery, via the switch, whilst the positive side of the battery connects to the earth line. This may prove a little unusual to those who normally construct valve equipment.

Alignment: The alignment of the tuner is quite simple, particularly if the constructor has access to an R.F. Signal Generator. However, good alignment can be achieved using only the broadcast stations. This is best carried out at night because some of the useful stations for alignment will be best received under night time conditions. However, if there are suitable local stations operating then alignment can be carried out any time of the day.

Firstly set the R.F. and detector trimmer capacities to approximately half value, determined visually. Then, unless you are very close to local stations (say 5 miles), connect a reasonably sized aerial and an earth. If necessary, string up 30 feet of wire as a temporary aerial.

Now some means of measuring the change in tuning adjustment is required. Either a 1,000 ohm per volt or better sensitivity voltmeter can be connected across the emitter resistor of the AF116 detector or a 0-1MA meter can be connected in series with the

ENQUIRY CARD AD. 9

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collector circuit of the detector.

If neither of these instruments is available, then the tuner will need to be connected to the amplifier and the volume of the received signals used as a tuning indication. Now set the series aerial padder to approximately half capacity and carefully tune for a local station operating near the high frequency end of the tuning range. (capacity plates unmeshed). If the signal generator is used, then tune it to a frequency around 1250 kc. with the modulation on. When a suitable signal is located, adjust both trimmers for maximum signal.

Now tune to the other end of the band (condenser plates nearly closed) and locate another station. If the signal generator is used, set this to a frequency near 600 kc. Now adjust the slugs in both coils carefully for maximum signal. Repeat this alignment at each end again and then seal the trimmers and the slugs with a drop of hot candle wax.

If a signal generator is available then the tuning range can be accurately set. Using a 420 pf. per section gang, the tuning coverage should be from 525 kc. to 1605 kc. To get correct alignment over this range it will probably be necessary to adjust the slugs in both coils with the capacity fully meshed to tune in 525 kc. Then tune to 1600 kc. with the tuning capacity fully unmeshed and adjust the trimmer capacities for maximum signal at this end of the band.

For optimum operation, either the length of the aerial or the capacity of the aerial series padder will have to be adjusted to strike an optimum condition for best selectivity and station separation, consistent with adequate signal pickup.

ENQUIRY CARD AD. 16

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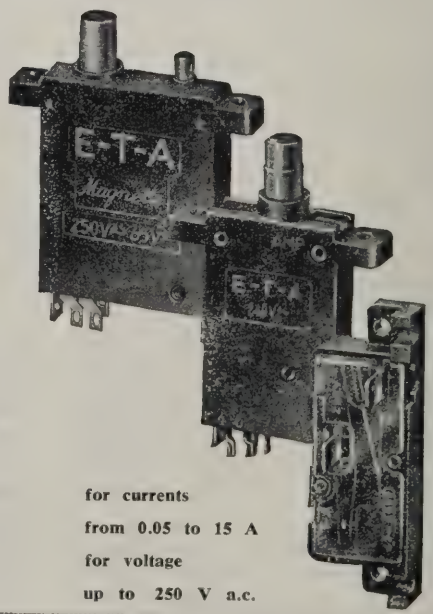

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High Impedance Microphone Sensitivity Chart and Decibel Chart

The advent of good quality amplifiers for entertainment use has meant that many users of portable equipment are no longer satisfied with poor quality voice reproduction from, say, a cheap dynamic microphone — or worse still, from a carbon microphone.

The need is for better quality calls for a more exact knowledge of the sensitivity of the microphone so that the amplifier input stages can be designed to accept the range of input levels.

High impedance microphone sensitivity is expressed as the voltage output when the transducer is subjected to a certain pressure. The usual expression is:

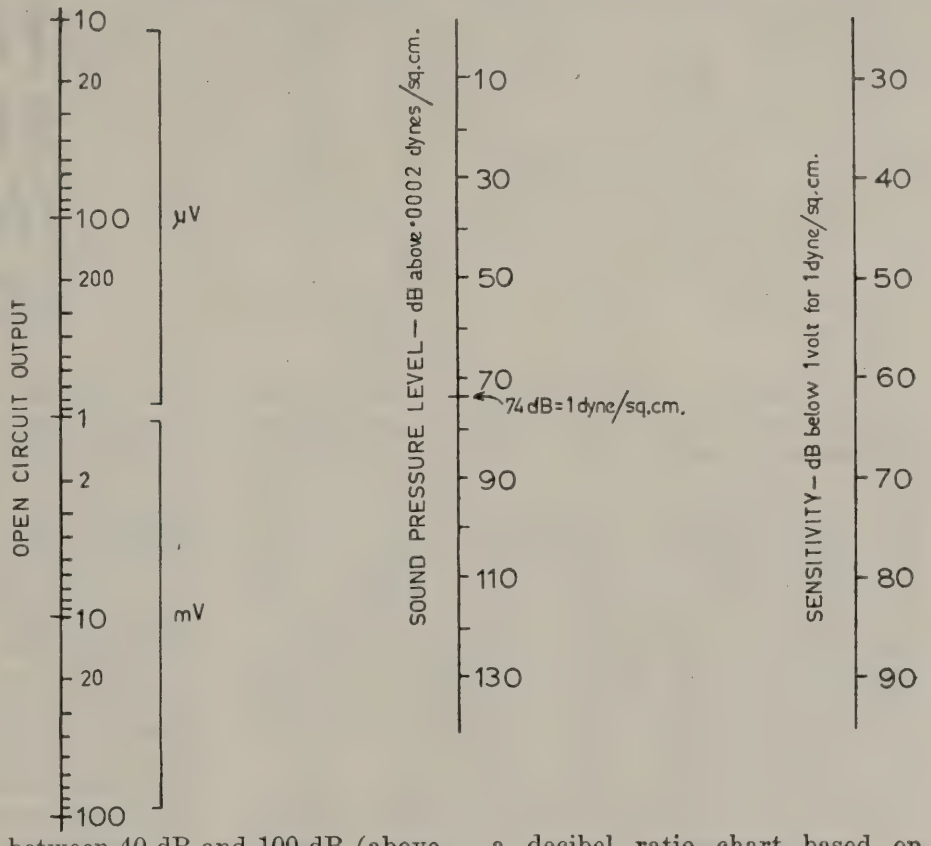
dB below 1 volt/1 dyne, sq. cm. that is, the microphone output voltage is X dB below 1 volt for a sound pressure level of 1 dyne/sq. cm. As it is not now usual to express sound pressures against this 1 dyne/sq. cm. reference we publish a chart giving outputs for various sound pressure levels against a range of microphone sensitivities.

The original level of 1 dyne/sq. cm. was chosen as this approximates to the levels 6in. from the average speaker's mouth. However, international Standards now refer to Sound Pressure levels above the reference of .0002 dynes/sq. cm. (OdB) — this figure being approximately the threshold of normal hearing at 1000 cycles. The threshold is, in fact, nearer 4dB up.

Certain Continental and American makers refer to 1 ubar instead of 1 dyne/sq. cm. — they are identical. To further confuse us the output may be given in actual millivolts rather than dB below 1 volt. (Remember 1 mV = −60 dB referred to 1 volt.)

The usual range of sensitivities for good high impedance microphones is between 50 dB and 70 dB below 1 volt/1 dyne, sq. cm.

For entertainment use the sound pressure levels from speech, singing or small orchestras range



between 40 dB and 100 dB (above zero reference) so that for a microphone with a sensitivity of −60 dB the open circuit output will vary between 20 μV and 20 millivolts — a dynamic ratio of 1000. Hence the need for VU meters or at least a "magic eye" level indicator to prevent overloading of the amplifier.

The effect of loading upon the microphone has not been considered but provided the input impedance of the amplifier is 3 or 4 times that of the microphone the output voltage will not fall by more than 1 dB or 2 dB. On the other hand by placing the microphone across an input impedance equal to its own impedance a 6 dB loss will result, that is the voltage will be halved. However, most microphone manufacturers indicate the desired terminating impedances, usually 1 megohm or greater for high impedance types.

For convenience of readers. and to make the sensitivity chart more useful, we are also printing a decibel ratio chart based on

$$dB = 20 \log N_2/N_1$$

where N_2/N_1 is the ratio of voltage, current or sound pressure but NOT power.

Soon we will publish a chart for low impedance microphones such as dynamic types.

TABLE OF VOLTAGE, CURRENT OR SOUND LEVEL RATIOS

Ratio Down	dB.	Ratio Up
.9772	.2	1.023
.9441	.5	1.059
.8913	1.0	1.122
.8414	1.5	1.189
.7943	2.0	1.259
.7499	2.5	1.334
.7079	3.0	1.413
.6310	4	1.585
.5623	5	1.778
.5012	6	1.995
.4467	7	2.239
.3981	8	2.512
.3548	9	2.818
.3162	10	3.162
.1778	15	5.623
.1000	20	10.000
.05623	25	17.78
.03162	30	31.62
.01000	40	100.00
.003162	50	316.20
.00100	60	1000.00
3.16 x 10 −4	70	3162
1 x 10 −4	80	10,000
3.16 x 10 −5	90	31,620
1 x 10 −5	100	100,000

LOOKING AT

TRANSISTORS SWITCHING INDUCTIVE LOADS

As transistors with higher and higher current, voltage and power ratings become available, so the load powers which can be handled also increase. Unfortunately, many of the high power loads are inductive rather than resistive, and this requires great care in design, particularly so when the load current has to be switched on and off rapidly.

If the load current is only changed very slowly, there is little difficulty since only the d.c. resistance of the load needs to be considered. However, there is a restriction on the load power in this case and it is important that this phenomenon should be understood before proceeding to discuss faster switching conditions.

If we consider a transistor with a resistive load R in the collector circuit, a supply voltage of V present, and a current I passing through the load and transistor, then the voltage across the transistor is $Vc = V - IR$.

The power dissipated in the transistor is

$$VcI = VI - I^2R.$$

If a curve of this power is plotted against the current I it will be seen that the power in the transistor is a maximum when the current is at one half its maximum value which is

$$V/R \div 2 = V/2R.$$

When operating with this current half the supply voltage V appears across the transistor and half across the load R, whilst the power dissipated in each is V2/4R, which is one quarter of the maximum possible load power V2/R.

Since the maximum transistor dissipation is $\frac{1}{4}$ of the maximum load power, it means that a transistor can control power almost four times its own rated maximum dissipation, assuming that the bottomed collector voltage is small compared with the supply voltage.

Thus we find that given a transistor having a rated dissipation of W watts, the minimum permissible load resistor value for slow speed switching with a supply voltage V is $V^2/4W$. It is also interesting to note that if the resistor has a greater value than $V^2/4W$, the rated transistor dissipation can never be exceeded at any collector current.

Now the value of rated power dissipation mentioned above can be a little misleading, as a design rating, since it is not the power dissipation itself which causes destruction of the transistor, But the attendant heat energy. This heat energy is the product of the power dissipation and the time for which it is dissipated, and it is quite possible to exceed the rated dissipation without destroying the transistor provided it is not exceeded for too long a time, and the condition is not repeated too often. When the transistor is being used as a switch it is not usual to require it to spend any time in a condition other than on or off. Thus if it can be switched from one state to the other quickly enough and infrequently enough, then the heat energy will be insufficient to cause any damage. By this means, it is thus possible to switch resistive load powers almost equal to the product of the maximum rated collector current and maximum rated collector voltage, and this product is usually greater than four times the maximum permissible dissipation. However, great care should be exercised when operating under these conditions.

When an inductive load is being switched, there is a vastly different set of circumstances prevailing. The inductance can only be ignored if the on-off state is very slow, and the rated dissipation must not be exceeded. If inductive loads are being switched rapidly then the conditions during switching must be carefully studied.

When a transistor with an inductive load is switched on, as soon as its collector current starts to increase, the load inductance produces an opposing induced E.M.F., almost equal to the supply voltage. Consequently, the transistor collector voltage very quickly falls almost to zero, and the current then builds up in an exponentral manner, rising to approximately .6 of its final value in a time equal to the load inductance divided by the load resistance. If the transistor is driven to the bottomed condition (fully conducting), then the final value of collector current is the supply voltage, less the voltage across the transistor which is small, divided by the resistance of the load. Generally speaking, the collector voltage collapses more rapidly than the collector current rises.

When the current flowing in the load is switched off, the voltage across the switch increases rapidly. This is because the load inductance, together with circuit capacities, forms a parallel

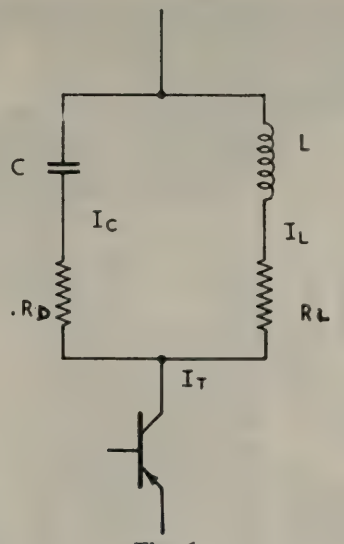


Fig. 1

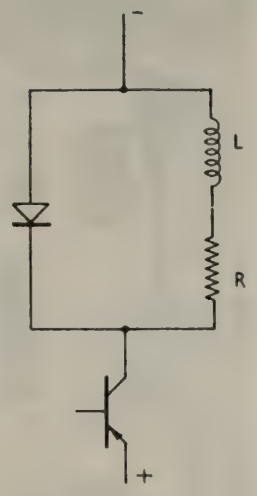


Fig. 2

tuned L-C circuit, which is excited by the rapid change of current. This energy, which is stored in the inductance, can produce destructively high voltages across the transistor switch. If this voltage is not limited by one of the methods mentioned later, it can rise to the point where the junctions can be permanently broken down and destroyed. In many cases this destruction voltage can be dependant on the conditions in the base circuit.

There are various ways of avoiding excess voltage when an inductive load is switched off. One such way is shown in Fig. 1. Here a capacity C is connected in series with a Resistor RD across the load which has inductance L and internal resistance RL. If we choose C so that CRD = L/RL, then when the transistor switches off, its collector voltage will rise immediately to that equal to the supply voltage. In fact, to the transistor the by-passed load looks just like a resistor of value Rd.

One problem here is the size of the capacitor required. It can be shown that the value of the capacity can be calculated from the formula $C = L \times 10^6/Rd^2$ microfarads where L is in henrys. It can be seen that low values of load resistance require large values of capacitance. In some cases, values less than optimum can be used. The only other problem is where the inductive load is an electromagnetic relay, design difficulties can be caused by the fact that the load inductance is not constant, but varies as the relay armature moves. This is not a severe problem with small relays but can become so with larger solenoids.

In Fig. 1, Rd the damping resistor in series with the capacitance should remove sufficient energy from the tuned circuit to prevent any undershoot of voltage causing difficulties by taking the collector potential below the base potential. Rd can be adjusted in value to produce a suitable value o.c. in the formula above. Ideally, the value of R should equal the reactance of C at the frequency of the oscillatory condition which is being damped.

As an alternative to the method of prevention of transient overvoltages discussed above, the arrangement of Fig. 2 can be used. Here a rectifier across the load prevents the transistor voltage from exceeding the supply voltage by more than the forward voltage drop across the rectifier. The rectifier must be capable of operating continuously with the operating voltage across the relay as reverse voltage across it.

As with the capacitance-resistance method, the current decay with switch-off, is exponential falling to 0.368 of its initial value in time equal to the load inductance divided by the load resistance. The main advantage of this method is its simplicity and is to be recommended. It should be noted that the stored energy in the inductance is returned to the supply by the diode. The power source must be capable of absorbing this energy without significant change in voltage. A Zener diode provides a very effective means of absorbing the energy at a convenient voltage.

Switching Times: The method used to control the surge voltage has a considerable effect on the time required to reduce the current in an inductive circuit below a given value. When diode protection is used, the current decays as mentioned above with a time constant, for a perfect diode of L/R. When a damping resistor-capacitor combination is used the energy stored in the capacitor will cause the current in the load to reverse, and the time taken for the current to fall to zero is approximately the time of $\frac{1}{4}$ of a cycle at the tuned circuit resonant frequency.

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"An Introduction to the Use of Transistors in Inductive Circuits," by A. F. Newell. Mullard Tech. Comm., Vol. No. 4, Nov. 1958.

"Transistors As Switches," by D. A. Smith. "Wireless World," April 1963.

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THE OPENING OF THE COMMUNICATIONS SECTION OF THE MUSEUM OF TRANSPORT AND TECHNOLOGY

Top: General view of part of the main hall from the door.

Middle: Old transmitting tubes associated with early radio in N.Z.

Bottom: Fully equipped and operational ship's wireless station; 1910.

The communications section of the Museum of Transport and Technology was opened together with another, the road transport section, on Wednesday, 14th October. Present at the Opening Ceremony with officers and Committee members, and several hundred invited guests, was the Director General of the Post and Telegraph Dept., Mr. Darnell, who opened the Communications Section; and Mr. W. Clement Stone from Chicago who read a letter of congratulations and goodwill from the President of the Chicago Museum of Science and Industry.

Due to the existing but it is hoped temporary shortage of accommodation space, the Communications committee and the many willing and voluntary helpers could not possibly place on display much of the very interesting communications equipment which has been collected over the past several years for ultimate restoration and display. However, working under difficult conditions, the committee nevertheless have produced an outstanding exhibition, some parts of which can be seen from the accompanying photographs. This exhibition will equal similar displays in other countries of the world.

The first photograph shows a general view of part of the main hall from the door. In the centre are some of New Zealand's early telephones and manual exchanges, all in working order and interconnected. Immediately behind and to the right of these is an early model of a P.A.B.X. Type 7001 exchange used in sub-exchanges and business houses. Alongside this but obscured in the photo is an early model automatic exchange, in full working order, operating from some modern desk type telephones stationed alongside. On the extreme left of the photograph are some of the first commercial radio-telephones used in vehicular service in any country outside the United States. These were designed and built in this country. In the centre of the photograph is a semaphore used for signalling between ships and shore. Alongside this is a double sided display of many kinds of early and current telephone multi-conductor cables, sub-marine and over-land cables together with more modern samples of intercontinental cables. This display is surmounted by pieces of the more modern multi-channel telephone cables such as "Compac" and "Cantat."

One of the examples of co-operative working for this museum is the display of thermionic radio valves. Part of this display can be seen in the second photograph.

Many of these valves, dating back to about 1910, were collected as the result of a nation wide appeal to all members of the electronics industry.

These valves on display fall naturally in five major sections, three of these being visible in the photograph. The first section, to the left of the display, illustrates the birth of the radio valve. This cabinet includes examples of the earliest valves manufactured, and some of those developed during the 1914-18 war. The development of the valve from the early triode of 1920 era through the tetrodes of 1924-30 is also shown, at the end of which period the basic features of the modern valve had emerged.

The second section of this display contains some old and historic transmitting tubes associated with the early days of radio in New Zealand. For instance, the transmitting tubes from the first 1YA station are amongst this collection. The third section of the display continues on from the previous cabinet and introduces the more modern types of valves including those developed for V.H.F. and television service. Typical of those exhibited in this cabinet is a Vidicon and Image Orthicon from television cameras. Many of the types shown are still currently in use in medium power sound and vision broadcast, amateur, ship and aircraft communications.

The fourth cabinet, out of sight to the right of the photograph, traces the evolution of broadcast receiving tubes from the commencement of organised broadcasting, through the period of World War 2 up to the present day.

In cabinets under the display stands, out of sight at the bottom of the photograph, are some of the very large water and forced-air cooled transmitting tubes. Amongst these are the actual tubes used in the original 2YA station. Contrasting with these are some of the smallest tubes made; early hearing aid and computer types.

Another part of the museum, unfortunately very restricted for space reasons, includes early radio components, crystal and battery receivers, many in working order, microphones and loudspeakers.

One of the museum's proudest exhibits is a fully equipped and operational ship's wireless station dating back to the year 1910. This is complete in all detail and can be seen in the photograph on last page. It has been restored to original condition after many years of storage from the time it was removed from the cable repair ship "Iris" in which it was installed in 1912.

Other sections of the exhibition not shown in photographs are operational simplex telegraph sets, cable code apparatus, Morse keys, sounders and early model teleprinter equipment. One of the highlights of this display is an operational teleprinter using a "Murray multiplex" system enabling four separate transmissions to be multiplexed down a single line. This was invented by the New Zealander Murray, and was a major advance in the communication systems.

The committee and helpers are to be commended on a well documented collection of exhibits which should prove exciting and interesting to technical and student viewers, as well as the general public.

VHF AERIALS

Part II

Radiation and Aerials

Below is the second section of a summary of the V.H.F. Aerial Course held at the Auckland Technical Institute between the 12th and 20th of August.

The course was arranged by the Auckland Technical Institute and conducted by Messrs. M. A. Jillings, A. Godfrey and R. Cochrane. As well as the lectures, considerable demonstration work was carried out using 100-yard lengths of 50Ω coaxial line to show reflected pulses under varying conditions of matching, and open and shorted terminations. Equipment was also set up to produce standing waves and a 144 Mc Yagi used to demonstrate the change of S.W.R. with change of element spacing, and the change in polar diagram with the change of element spacing and link.

Electromagnetic Radiation

V.H.F. radiation is the result of the acceleration and deceleration of electrons along suitably arranged conductors. The extremely small individual wavelets of electromagnetic energy arising from each charge particle will, in practical aerial systems, tend to cancel in some directions, but should largely reinforce each other in the direction in which the radiated energy is required. The resultant effect of these combined wavelets of energy is an apparent continuous flow of transverse plane wave motion.

The velocity of the radiated wave in free space is constant C,

where $C = 3 \times 10^8$ metres per second

$= 984 \times 10^6$ feet per second.

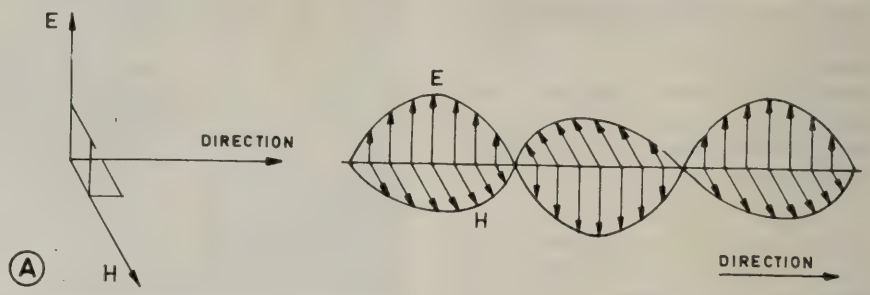
Sinusoidal waveform is used to produce the electromagnetic wave which has a free space wavelength λ.

$\lambda = 300/(f)$ metres, where f is the frequency of the wave in megacycles per second.

Because the wave spreads in a spherical manner from its source, the energy falls inversely with the square of the distance, r.

Since the electric field E is proportional to the square root of P ($P = E^2/R$), E in volts per metre is inversely proportional to the distance.

The wave has equal electric and magnetic components, but it is usual to consider only the electric field. At a distance from the source, the E.M. wave has a plane wavefront. The electric (E) and magnetic (H) fields oscillate in phase, but are at right angles to each other and the direction of travel. The polarisation of the wave is taken as the direction in which the E component oscillates.



Vertical Polarised Wave — showing transverse components.

The Isotropic Radiator

If the power, P, radiated from an aerial flowed out equally in all directions, at a distance r from the source of radiation, the power would be flowing uniformly through a sphere of area $A = 4\pi r^2$ square metres.

The power per unit area,

$Pw = P/(4\pi r^2)$ Watts per square metre,

$= E^2/(120\pi)$.

Therefore, the Field Strength, E, of an Isotropic Radiator is

$E = \sqrt{(30P)}/r$ Volts per metre.

Field Strength of Practical Aerials

It is very difficult and, apart from space ventures, undesirable to simulate an isotropic radiator. For example, in the case of a halfwave aerial in free space, the field strength at a distance from the aerial is a maximum at right angles to the direction in which the charge flows along the conductor. The field strength falls approximately to the cosine of the angle of direction, being zero at 90 degrees, or in line with the conductor.

Because less power would be required to give the same field strength at a distance r from a transmitter when using a halfwave aerial than the isotropic radiator, the halfwave aerial is said to have a Power Gain.

Power gain of halfwave aerial over an isotropic aerial is 1.6 or 2db, giving a free space field strength in its best direction,

$Eo = \sqrt{(30 \times 1.6P)}/r$

$= 6.9\sqrt{P}/r$ Volts/metre.

It is convenient to measure the gain of directive aerial arrays with respect to a halfwave aerial. When this is done it should be quoted as db gain over a halfwave aerial.

In general,

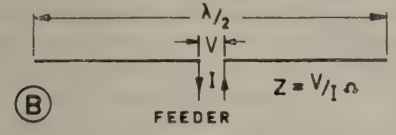
$E = 69\sqrt{(gP)}/r$, Volts/metre, where g is the gain of the aerial over that of a halfwave aerial.

HALFWAVE OR DIPOLE AERIAL

When a half wavelength of conductor is fed in the centre, energy reflected from the ends of the conductor sets up a standing wave. Since current must flow before potential can build up between the ends of the conductor, and the current falls to zero as the potential reaches its maximum value, the magnetic and electric fields are 90 degrees out of phase with each other. These fields are called the Induction Fields. Neighbouring mediums are effected and in return reflect their influence on the conductor as a result of these fields. Remember, the radiated field is the result of the acceleration and deceleration of charge—the rate of change of current in the conductor. The radiated field is 90 degrees out of phase with the magnetic induction field.

The induction field falls inversely with the square of the distance, becoming negligible a few wavelengths from the aerial.

Resonant Length—Feed Impedance (Current-Fed)



(B)

If a dipole is cut to exactly λ/2, and situated several wavelengths above earth, its centre impedance is found to be 73 ohms resistive, plus 40 ohms of inductive reactance.

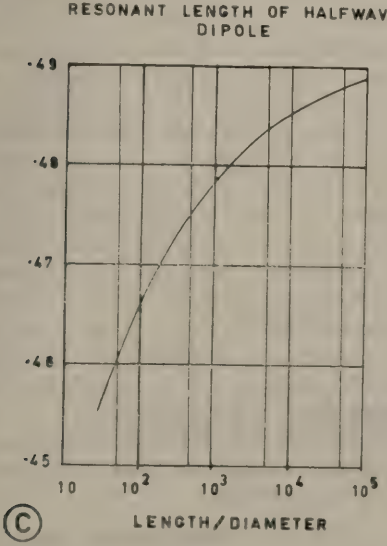
The reactive component exists because there is more energy stored in the magnetic induction field than the electric field. This effect is eliminated by reducing the length of the conductor until the two induction fields contain equal energy. The aerial is then purely resistive-resonant. The percentage of reduction necessary to resonate a dipole, increases as the ratio of wavelength to conductor diameter is reduced.

If the dipole losses (which produce heat) are neglected, the radiated power, P, which flows from the dipole is:

$Pr = I^2Rr$ Watts, where I is the value of current fed to the centre of the dipole and Rr is the resistive component.

or $Rr = Pr/I^2$ Ohms.

The ratio of the total power radiated by an aerial and the square of the current at the point where the power is introduced, is called the **Radiation Resistance.**

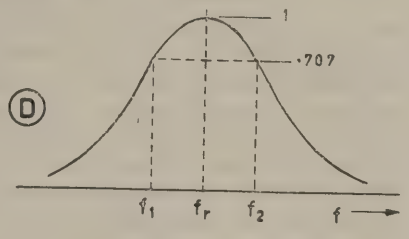


(C)

The Bandwidth of a Halfwave Dipole ('Q' Factor)

The centre-fed aerial has an input impedance which is purely resistive (73 ohms) when slightly shorter than a half wavelength, inductive when longer and capacitive when shorter than the resonant length. It behaves like a series tuned circuit. The selectivity or response curve of such a circuit is indicated by its Q-factor.

$Q = fr/(f_2 - f_1)$ where fr is the resonant frequency, and f_1, f_2, the frequencies at which the response falls to 70.7% or half power.

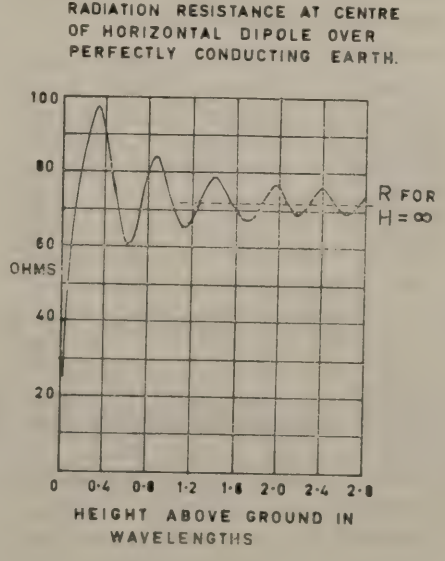


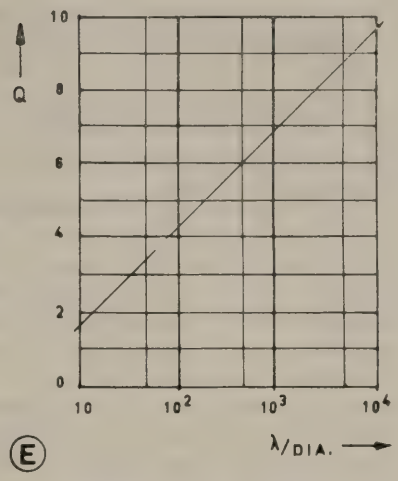
(D)

The Q-Factor of a Resonant Dipole

The Q-factor is proportional to the ratio of energy stored in a circuit to the energy lost, being equal to the ratio of reactance to resistance.

The reactance of a halfwave dipole it was previously stated, varied with the ratio of wavelength to conductor diameter. The radiation resistance also changes with this ratio, falling to approximately 60 ohms when the ratio is 50.





(E)

RECEIVING AERIALS

General

The spherical wavefront from a transmitting aerial at large distances presents effectively a plane wavefront to the small area of space occupied by a receiving aerial. The wave sets up an E.M.F. in the receiving aerial which depends on the field strength and direction from which the wave is incident. Plotting this E.M.F. against direction for a given signal source, gives the field-strength diagram of the receiving aerial.

If an aerial received equally in all directions it would be referred to as an Isotropic receiver. Practical aerials, however, have the same directional properties whether they are used for transmitting or reception, and the isotropic receiver is again a hypothetical aerial. Receiving aerials have power gains which can be expressed as relative to the isotropic aerial, but for convenience in common with transmitting aerials, is usually related to the halfwave dipole. (Gain of halfwave dipole is approximately 3/2 relative to an isotropic antenna.)

In order to utilise the E.M.F. set-up in a receiving aerial, a load (receiver input circuit) must be attached to the aerial terminals. For maximum transfer of energy from the aerial to the load, the load resistance should equal the aerial resistance. Under matched conditions, half the power is absorbed by the load and the other half is re-radiated by the aerial. (Neglecting dielectric, resistance and transmission line losses.) If no load is con-

nected to the aerial, all the energy is re-radiated.

When the gains of receiving aerials are compared it is assumed that the aerials are matched to the load and receiving in the optimum direction.

Since receiving aerials have the same three properties of Power Gain, Impedance, and Field Strength Diagram as transmitting aerials, when dealing with the properties of a particular aerial it is usual to treat it as a transmitter. The resulting characteristics are equally applicable when the aerial is used for reception.

Capture or Aperture

The power flow of the incident wave on a receiving aerial is

$Pa = E^2/120\pi$ Watts/square metre.

When the aerial is placed normal to the direction of the wave, some of this power is intercepted and transferred to the load. The absorption property of the aerial has an Effective Cross-sectional Area A square metres and the power Po in the load is given by

$Po = PaA$ watts.

For a halfwave dipole,

$A = 3/2\ (\lambda^2/4\pi)$.

This is commonly called the Capture Area of the receiving aerial and if the gain of an aerial relative to a halfwave dipole is Gd, then

$A = 3Gd\lambda^2/4\pi$.

If the field strength of the wave is E volts/metre, then the power P in the matched load of any receiving aerial is given by

$P = GdE^2/80\ (\lambda/2\pi)^2$ Watts.

Transmitter-Receiver Example

A transmitter operating at 200 Mc/s supplies 20 watts of power to an aerial with an effective gain of 12 db. A receiver is located 50 miles away and connected to an aerial with a gain of 6db. The effect of ground reflections is ignored. When both aerials are aligned for optimum performance, what is the signal voltage across the input terminals of the receiver which is correctly matched to 50 ohms cable?

Power gain of 12db = 16 times

$E = 6.9\sqrt{}\ (20 \times 16)/80 =$ 1.5 millivolts/metre.

Power gain of 6db = 4 times

$\lambda = 300/200 = 3/2$ metres.

Power delivered to receiver input terminals

$P = [4 \times (1.5)^2/80 \times 10^6]\ (1.5/2\pi)^2$ Watts

$= 0.013$ microwatts

$= V^2/R$ where V is the receiver input voltage, and R is the input impedance,

$V = \sqrt{50 \times 0.013 \times 10^{-6}}$ Volts

= 0.8 millivolts.

POLAR DIAGRAMS

The polar diagram or field pattern of an aerial shows the variation of the electric field intensity at a constant radius as the angle is varied. The aerial may be transmitting, in which case a field-strength meter is used at a fixed distance while the aerial is rotated, or a signal source may be located some distance from the aerial, and its signal voltage measured as it is rotated. The field pattern may be **absolute** and the intensity expressed in volts per metre, or **relative**, the reference being the intensity in the direction of maximum field strength. Sometimes a power pattern is plotted. This will appear sharper than the field pattern—for example, when the relative field strength has fallen to 0.707, the power has fallen to the square of this value, or 0.5 (half power point). The plot can be taken in either the horizontal or vertical plane, and is referred to as the Horizontal or Vertical Polar Diagram.

The Polar Diagram of Two Spaced Halfwave Dipoles

The field patterns for two radiating elements have been calculated for many spacings and changes in the phase of currents supplied to each aerial. Numerous textbooks describe the method which is an extension of that already indicated for the halfwave dipole, and a variety of polar diagrams for fixed conditions are illustrated. If the aerials are initially resonated separately, it is found that the mutual coupling of the aerials when together makes them reactive, so that it is necessary to change their lengths to bring them into tune. The resistance of the aerials also changes with the spacing.

Reflector-Type Aerials

If a large flat sheet of perfectly conducting material is placed a distance S behind a halfwave dipole, the resulting field pattern can be calculated in terms of an additional Image dipole the same distance behind the sheet. Because losses exist in practice, there is little gain increase if S is reduced below $\frac{1}{8}$ wavelength. The radiation resistance falls when S is small, as already indicated in the graph for the dipole over perfectly conducting earth.

Although a reflecting screen of wire netting lowers the efficiency and permits some leakage in the back direction, the windage area of solid reflectors required for V.H.F. aerials makes them undesirable, and netting is usually used. The loss in iron wire rules it out unless well coated with zinc or tin. The thicker twisted wire mesh should lie in the direction of the electric field to reduce loss.

Parasitic Reflectors

If two aerials are placed a quarter wavelength apart and only one aerial is conected to the transmitter, the second aerial is excited by the fields of the first and is called a Parasite, the first being termed the Driver. By making the parasite slightly longer than resonance length and therefore inductive, the combined effects of the phase shift introduced by its length and the spacial delay of the field passing from driver to parasite causes reradiation which cancels some of the energy in this direction but reinforces it in the return direction to the driver. Since the parasite acts as though it has reflected the energy, it is called a Reflector. The distance can be reduced to about 0.1 of a wavelength provided the length of the parasite is increased. Because more energy is induced in the parasite as the distance is reduced, the forward gain increases but the radiation resistance falls to a low value.

(Continued on page 24)

ENQUIRY CARD AD. 10

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Except where stated all 230 V. Primary

PT	1	150/150 V	30 Ma.	6.3 V	2 Amp.			
PT	2	220/220 V	40 Ma.	6.3 V	2 Amp.			
PT	3	260/260 V	60 Ma.	6.3 V	2 Amp.			
PT	4	280/280 V	60 Ma.	6.3 V	2 Amp.	5 V 2 Amp.		
PT	5	350/350 V	60 Ma.	6.3 V	2 Amp.	5 V 2 Amp.		
PT	6	115/115 V	65 Ma.	6.3 V	1 Amp.			
PT	7	115/V ½ Wave	65 Ma.					
PT	8	280/280 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.		
PT	9	310/310 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.		
PT	10	350/350 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.		
PT	11	310/310 V	100 Ma.	6.3 V	4 Amp.	5 V 2 Amp.		
PT	12	350/350 V	100 Ma.	6.3 V	4 Amp.	5 V 2 Amp.		
PT	13	310/310 V	125 Ma.	6.3 V	4 Amp.	5 V 3 Amp.		
PT	14	310/310 V	150 Ma.	6.3 V	5 Amp.	5 V 3 Amp.		
PT	15	400/400 V	150 Ma.	6.3 VCT	5 Amp.	5 V 3 Amp.		
PT	16	400/400 V	150 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.	
PT	17	450/450 V	150 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.	
PT	18	450/450 V	200 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.	
PT	19	500/500 V	200 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.	
PT	20	595/595 V (500 V DC)	350 Ma. Choke Input					
PT	21	890/890 V (750 V DC)	250 Ma. Choke Input					
PT	22	295/295 V	360 Ma.	6.3 V	10 Amp.	5 V 3 Amp.	Sec. Tapped 240/240 V	
PT	24	Suitable for use with either RCA or Philips TV Kits Primary 0.210, 220, 230, 240 V. Pri. 0-230-270 V		6.3 V	5 Amp.	6.3 V 5 Amp.	5 V 2 Amp.	
		Used in TV Receiver with Mains Rectification.						
PT	25	115 V 360 Ma. 12.6 V 5 Amp. CT used with Silicon Diodes in Voltage Doubler Circuit.						
PT	26	280/280 V	80 Ma.	6.3 V	4 Amp.	6.3 V 1 A.		
PT	27	280/280 V	125 Ma.	6.3 V	5 Amp.	CT 6.3 V 1 A.		
PT	28	280/280 V	175 Ma.	6.3 V	4 Amp.	CT 6.3 V 4 A.	CT 5 V 3 A.	
PT	30	104 V	150 Ma.	6.3 V	5 Amp.	CT		
PT	31	126 V	125 Ma.	6.3 V	3 Amp.	CT 6.3 V 3 A.		

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WEIGHT: 5¾lbs.

MEASUREMENTS: 11in. wide, 3⅜in. deep, 6½in high

CABINET FINISH: Vinyl coated fabric.

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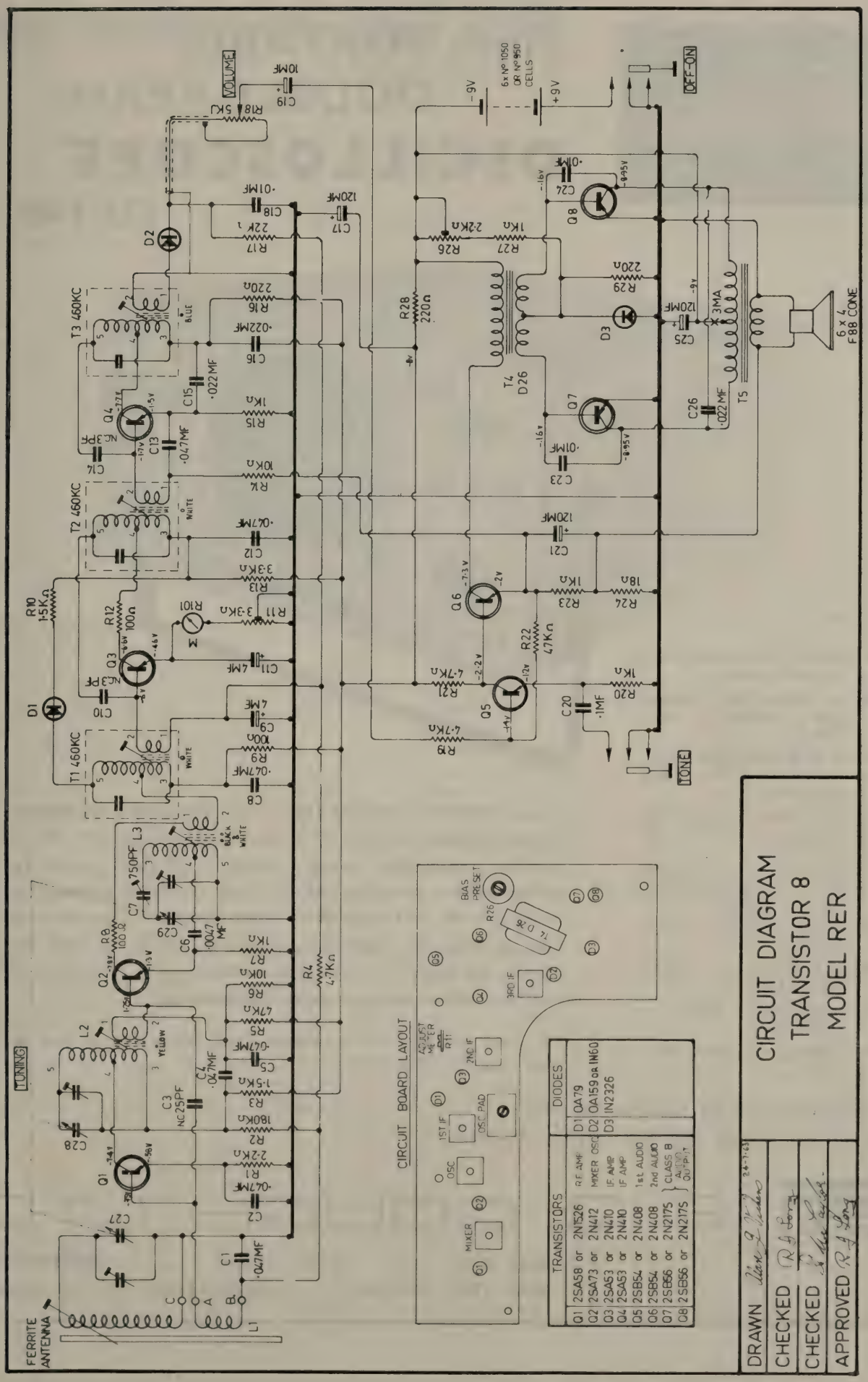
	Mixer Oscillator		2SA 73/2N 412
	1st I.F. Amplifier		2SA 53/2N 410
	2nd I.F. Amplifier		2SA 53/2N 410
	1st Audio		2SB 54/2N 408
	2nd Audio		2SB 54/2N 408
	Class "B" output		2SB 56/2N217s
Diodes	D1	OA79	
	D2	OA159	
	D3	IN2326	


CIRCUIT DIAGRAM
TRANSISTOR 8
MODEL RER
DRAWN
CHECKED
CHECKED
APPROVED
CIRCUIT BOARD LAYOUT
TRANSISTORS
DIODES
Q1 2SA58 or 2N1526 RF AMP
Q2 2SA73 or 2N412 MIXER OSC
Q3 2SA53 or 2N410 IF AMP
Q4 2SA53 or 2N410 IF AMP
Q5 2SB54 or 2N408 1st AUDIO
Q6 2SB54 or 2N408 2nd AUDIO
Q7 2SB66 or 2N2175 CLASS B AUDIO OUTPUT
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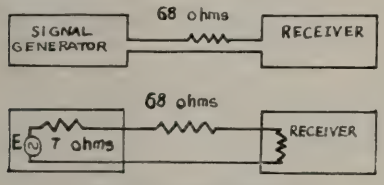
Signal Generators and Dummy Aerials

By C. W. MAYES *
Christchurch

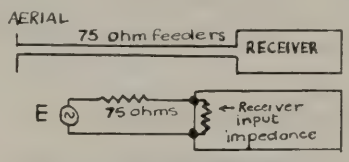
When carrying out a sensitivity check on a receiver, the instructions followed run somewhat as follows: "Using a Blank Type X Signal Generator, apply a signal of 1 microvolt to the receiver input via a 68 ohm carbon resistor." The Signal Generator is provided with a calibrated attenuator and is readily set for 1 microvolt output. But is this 1 microvolt across the receiver terminals, and what is the function of the 68 ohm dummy aerial specified in this case?



Top: Actual Circuit.
Bottom: Test Circuit.

Operating Conditions

When in use, the receiver in the example is designed to operate from 75 ohm feeders. Assuming correct matching of the aerial, the aerial system appears to the receiver input as a generator having an internal resistance of 75 ohms. Thus, if the e.m.f. applied to the feeders is 1 microvolt, and the receiver input impedance a pure resistance of 75 ohms, the voltage across the receiver terminals will be 0.5 microvolt. Putting this another way, if the receiver is exactly matched, the receiver 'receives' half the available signal voltage.



Top: Actual Arrangement.
Bottom: Equivalent Circuit.

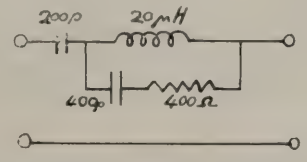
Test Conditions

The test conditions must exactly simulate the operating conditions. For this reason, the total internal resistance of the generator is made up to 75 ohms by adding the external dummy aerial of 68 ohms. If 1 microvolt is set on the signal generator, 0.5 microvolt will appear at the receiver terminals.

The same result could be achieved whatever the internal resistance of the signal generator; if the signal generator internal resistance is less than the required value, by adding series R, if greater by adding parallel R. As an example of the latter, if the signal generator output resistance is 150 ohms, to match 75 ohms, 150 ohms is connected in parallel with the signal generator and the signal generator e.m.f. is read as half the value shown on the attenuator. Under these conditions, if 1 microvolt is set on the attenuator, 0.25 microvolts appears across the receiver terminals.

If the receiver input impedance remained a pure resistance of fixed value throughout its tuning range, the sensitivity test could be carried out more easily by omitting the dummy load and using a signal generator of low internal resistance. However, the receiver input impedance is far from constant throughout its tuning range, so that in practice, the share of the signal e.m.f. appearing across the receiver terminals varies with frequency; this condition must be duplicated in the test set-up.

The fact is that improved signal-to-noise ratio may be obtained by deliberately mismatching the receiver input impedance and the feeder impedance. Also, the reactance of the coupling circuit normally varies with frequency. Thus the test as laid down in most manufacturer's manuals adopts the only feasible solution: by making the signal generator output resistance simulate the feeder characteristic impedance, the same fraction of the applied e.m.f. is lost under operating and test conditions.



All-wave receivers, intended to work directly from an L-type aerial, present a slightly more complex problem in that aerial impedance changes with frequency. When carrying out a sensitivity test on a receiver of this type, the effective internal impedance of the signal generator is varied with frequency by placing the standard dummy aerial shown between the signal generator and the receiver.

At broadcast frequencies the dummy aerial is capacitive, becoming resistive in the shortwave bands. This simulates the behaviour of the L-type aerial, so that the share of the open-circuit e.m.f. actually across the receiver terminals is the same, whether the receiver is connected to the signal generator or the receiver.

Extracted from the recent N.Z. Electronics Institute Newsletter:

TRANSISTOR HI-FI

Mild controversy, which has simmered over the valve versus transistor hi-fi for some years, shows signs of resolving. A famous amplifier maker has demonstrated his new transistorised stereo amplifier in London before acknowledged experts, who were unable to detect the difference between the new, and the similar "old" valve model. The three acknowledged differences, transistor weight, volume and price, were 48%, 43% and 89% of the valve equivalent. No claims were made for the magic of solid state sound, so perhaps we must wait for some such advertisement before admitting that transistors have arrived.

SOLID-STATE RELIABILITY

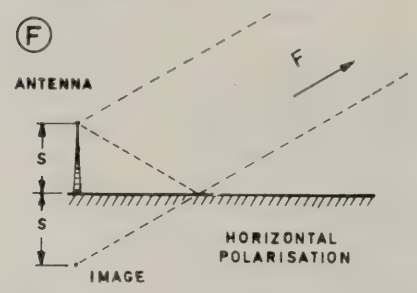
Reliability as an engineering term is becoming so highbrow that mere words are inadequate, but a recent factual comment is revealing. It has been stated that, in a survey of a piece of unspecified electronic equipment, 75% of the faults were caused by transistors although they comprised only 8% of the components. Perhaps a case can be put for plug-in transistors after all!

V.H.F. AERIALS—Radiation and Aerials

—continued from page 18

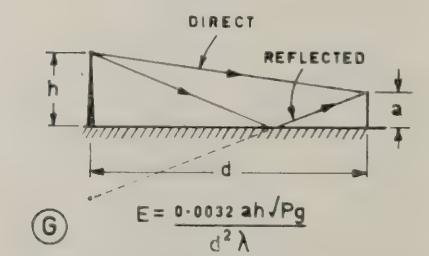
EFFECT OF EARTH ON RADIATION PATTERNS

At low radio frequencies the earth acts as an imperfect conductor, but at V.H.F. it behaves as a dielectric. As a result, horizontally and vertically polarised aerials behave differently.



The reflected wave acts as though it originates at an image, the same distance below the ground but with 180 degrees phase reversal. This results in cancellation along the ground, and an increasing number of lobes in the vertical plane as the aerial is raised above ground in halfwave steps.

When the field strength is measured close to ground at a distance d, the interference of the direct and reflected waves is most apparent. The field strength is then given approximately by



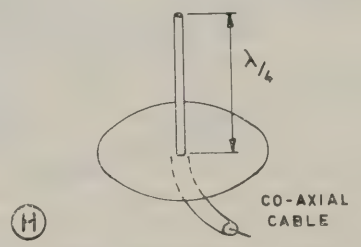
where h and a are the heights of the transmitter and receiver aerials respectively, measured in **feet**, and d, the distance in **miles.**

Vertical Polarisation

Up to about 17 degrees angle above earth, reflection with phase reversal takes place. Above this angle no change of phase takes place. The effect of ground on the vertical P.D. is therefore different at high angles to horizontal aerial polar diagrams. The phase reversal at low angles is in contrast to H.F. effects, where the earth acts as a conductor and reflects the vertically polarised wave without reversal. The wave is therefore reinforced at the lower frequencies, but cancellation takes place along the ground at V.H.F.

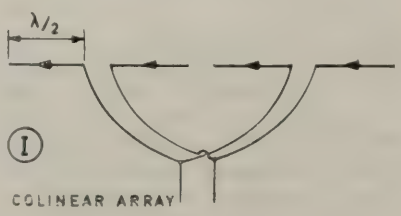
Ground Plane Aerial

A very convenient omnidirectional (circular horizontal P.D.) aerial for V.H.F. short range communication, uses a quarterwave aerial, mounted on a circular ground sheet of metal about ½ wavelength in diameter. The feed impedance is about 50 ohms, convenient for coaxial termination. Broadband characteristics are obtained by increasing the diameter of the aerial, or in the case of the Discone aerial, using a disc for the quarterwave stub, and a cone in place of the ground sheet.

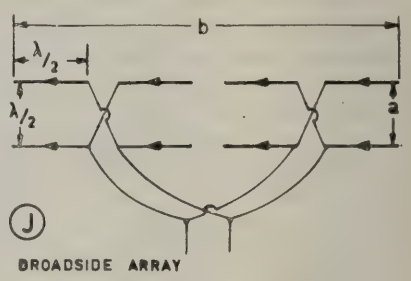


Beam Aerial Arrays

By arranging halfwave dipoles in line and feeding them all **in phase** the energy adds at a distant point broadside to the line of dipoles and cancels at certain horizontal angles from the maximum. Smaller maxima or side lobes exist, the number increasing, but relative field strength falling with the number of dipoles used. The dipoles are usually end fed. The impedance of each pair falls from 4,600 ohms for conductor diameters of 1/10,000 wavelength, to 920 ohms for a diameter of 1/100 wavelength.



Stacks of co-linear arrays can be arranged vertically, and again fed in phase. The radiation is further increased by placing a reflector sheet (or mesh) behind the array. When a large number of elements are used the main lobe becomes very much stronger than the numerous side lobes. The gain is given approximately by $G = 12ab/\lambda^2$ where a is the height and b the width of the array.



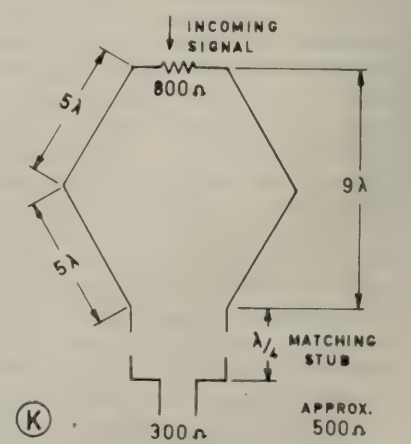
The Beamwidth is taken as the angle between the points on the Polar Diagram at which the field strength has fallen to 70.7% of maxima, which is the same as the angle between the maxima and first minima.

For the broadside beam array this angle is approximately equal to

$$\frac{70 \times \text{wavelength}}{\text{width of array}} \text{ degrees.}$$

Rhombic Aerials

Multiple lobes result when a wire of several wavelengths length is used as an aerial. Major lobes exist towards the end fire line of the aerial. By arranging the wire in a rhomboid the major

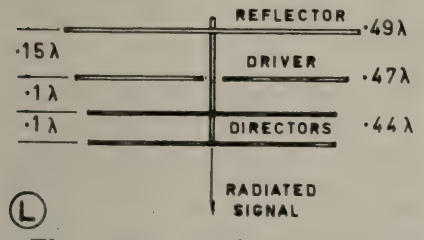


lobes reinforce in one direction. Terminating the wire at one end with a resistance gives the system a uni-directional pattern.

In the diagram of the typical rhombic antenna the gain of the array using leg lengths of 5 wavelengths is 11db.

The Yagi Array

The popularity of this array for V.H.F. transmission and reception is largely because of the ease with which the elements can be supported.



The array consists of a halfwave dipole, the Driven Element, and one or more parasitic elements. The principle of the reflector parasite has been covered.

Director parasites are cut shorter in length than resonance. The spacing of the capacitive element is adjusted so that the re-radiated energy initially induced by the driven element, reinforces the radiation from the direction of the driven element to itself. The energy radiated in the back direction partly cancels the driven element radiation.

Several directors can be used, and the spacing adjusted to suit variation in the lengths of the elements. Increasing the number of elements and reducing the spacing between them, both have the effect of lowering the feed impedance of the driven element, which is frequently less than 10 ohms.

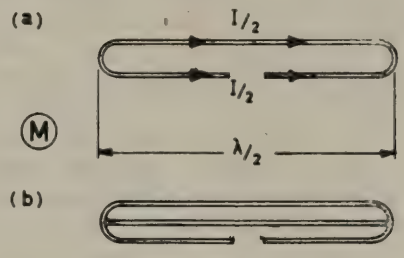
The Folded Dipole

By folding a full wavelength of conductor back on itself the feed impedance of a halfwave dipole can be increased to approximately 300 ohms. This effect can be seen by considering the currents which cause the radiated field as divided between the feed and return sections. For the same power,

$P = I^2 R_1$ where R_1 is the impedance of a halfwave dipole,

$P = (I/2)^2 R_2$ where R_2 is the impedance of the folded dipole,

Therefore $R_2 = 4R_1 = 4 \times 73$ ohms which is approximately equal to 300Ω.



The low impedance of the multi-element yagi can be increased by the folded dipole, improving the matching to feeders. By using 3 rods as in Part B of the diagram the feed impedance can be increased 9 times. A yagi with close spaced elements giving a dipole driver the impedance of 10 ohms can have its feed impedance increased to 90 ohms. The feed impedance of the folded dipole can also be altered by varying the ratio of the diameters of the feed and return conductors. The currents are divided proportionally to the ratio of the diameters, and therefore the conductor with the smaller diameter exhibits the higher centre impedance.

Frequency Bandwidth of Folded Dipoles

An added advantage of the folded dipole is its broader frequency response compared with the ordinary dipole. This is in part explained by the lower Q factor of the folded dipole, but also because it has in effect two short-circuited quarterwave transmission lines across its centre. Whereas a dipole becomes inductive when operated above its resonant frequency, a shorted quarterwave section becomes capacitive. One effect tends to cancel the other. The reverse effects take place when the aerial is operated below its resonant frequency.

OTHER V.H.F. BEAM ARRAYS

Numerous types of arrays have been described over the years, but most practical types are covered in handbooks such as the R.S.G.B. Amateur Radio Handbook, A.R.R.L. Handbook, TM11-666 Department of the Army—"Antennas and Radio Propogation." "Antennas," by Kraus (McGraw-Hill) gives full mathematical treatment, or references to the treatment, of most types of V.H.F. aerials. "Television Engineering Handbook," by Fink (McGraw-Hill) and "Television"; Second Edition; by Zworykin and Morton (Wiley) covers most of the standard TV transmission aerial systems.

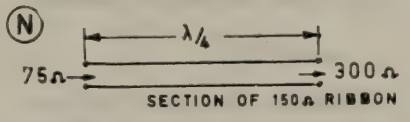
MATCHING SECTIONS

The feed impedance of beam arrays is frequently different from that of the feeder used. Reactance may also exist at the feed point. The S.W.R. (and loss) is reduced by utilising matching sections of transmission lines. L.C. filter sections may be used for low power transmitter or receiver matching purposes, but the losses are increased.

Aerial systems are usually balanced, and it is necessary to use Baluns (balance-unbalance transformers) if coaxial lines are used as feedlines.

Matching sections and baluns are resonant devices, and therefore rather frequency sensitive. However, wideband techniques can be used to extend the range of frequencies over which they work.

The Design of a Quarter Wavelength Matching Section



Example: An aerial on 200 Mc/s with 75Ω feed impedance is to be matched to a 300Ω ribbon type feeder.

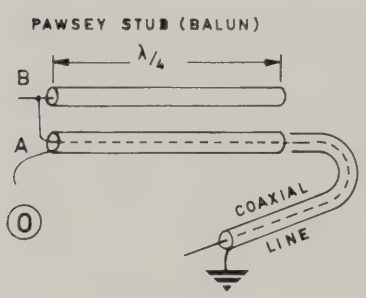
$Z_o = \sqrt{Z_1 Z_2} = \sqrt{75 \times 300} = 150\Omega$.

A section of 150Ω ribbon cable could be used.

Velocity factor of 150Ω ribbon = 0.71.

Length of matching section $= (300 \times 0.71 \times 39.37)/(200 \times 4) = 11\frac{3}{4}$ inches.

The potential at the coaxial end of this stub, can be expressed as V volts with respect to earth.



A standing wave exists along both sections of the stub and the resulting potentials at points A and B are both V/2 with respect to ground, but remains V across AB provided the coaxial section is the same impedance as the coaxial line. However, the section can be used as a quarterwave matching section at the same time.

Example: A dipole with a feed impedance of 38Ω is to be fed from a 75Ω coaxial cable at a centre frequency of 202 Mc/s. What are the dimensions of a suitable pawsey stub?

Length of stub,
300/(202X4) x 39.37
= 14.6 inches.

Quarterwave coax. Zo = $\sqrt{(75 \times 38)} = 54\Omega = 138 \log_{10} (R_2 \div R_1)$.

$\therefore R_2/R_1$ = antilog 54/138 = 2.5/1.

ENQUIRY CARD AD. 11

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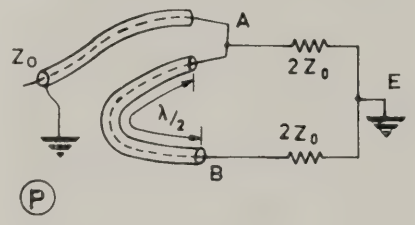
Refer here to Graph shown in Part 1 of this series under the heading "Transmission Lines."

The stub could be constructed from two 14.6 inch lengths of copper tubing with 5/16 inches internal diameter. The inner conductor would then be $\frac{1}{8}$ inch diameter.

The stub could also be used to mechanically support the aerial, or act as a quarterwave "Metallic Insulator."

Halfwave Coaxial or Trombone Balun



If a halfwave section of coaxial line is used across a balanced load, the impedance of one half of the load (B) is reflected in parallel with the other half (A). The resultant impedance across the balanced output (AB) is therefore four times the input impedance (Zo). Since there is 180 degrees phase change across the halfwave section, the output is balanced with respect to earth.

Example: A folded dipole (impedance 300 ohms) is to be matched to a 75 ohm coaxial feeder. Describe a suitable matching section.

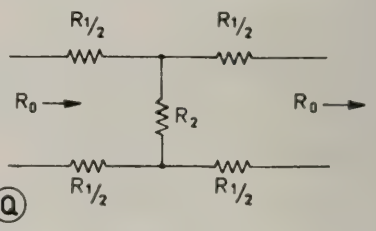
The impedance transformation required is 300/75 or 4:1. A balun is also required, so the halfwave "trombone" type would be satisfactory. Allowance must be made for the velocity factor of the cable when cutting the halfwave length.

Stub Matching Systems

Short lengths of line placed across the main feeder line are frequently used to tune out the reactance and transform the impedance of a load to match the line. A single stub of variable length up to a halfwave, which can be shifted along the feeder, close to the load, provides a means of matching by trial and error. An increase in the number of stubs used increases the bandwidth.

Receiver Attenuator and Multi-outlet Pads

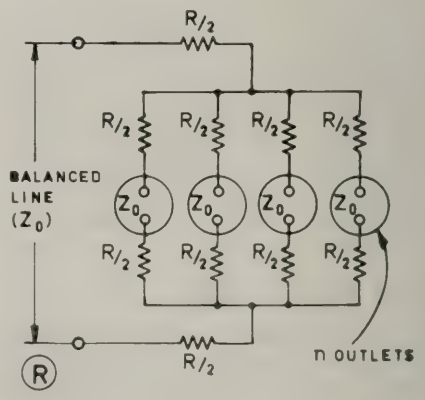
It is frequently desirable to attenuate the signal pickup of a



TV aerial system at the receiver input. The directivity properties of a high gain aerial may combine with the attenuator in suppressing reflection ghosts. It is also possible to prevent feeder mismatch from affecting the picture quality. Where Ro is the feeder and input impedance, and A is the ratio of input to output voltage then

$R_1 = Ro\ [A - 1/A + 1]$
and $R_2 = Ro\ [2A/(A+1)\ (A-1)]$

When a number of receivers are operated from a common aerial, a resistance network can be used to maintain correct matching. If n outlets are required, then the attenuation from the feeder to each receiver is 20 log n db.



$R = Zo\ (n - 1/n + 1)$.

If any receiver is disconnected, a resistor of value Zo should be connected across its socket in diagram, or across the receiver end of the line extending from the socket. Otherwise value of R/2 ought to be re-calculated using the changed value of n.

A REPORT FROM THE INTERNATIONAL TRADE FAIR

Our reporter was privileged to visit the Second International Trade Fair in Wellington recently. Unlike the usual local Industries Fairs this one distinguishes itself in that the displays in general are in "Country Courts." Under this system various countries (at least nine including New Zealand) arrange complete courts usually round a central theme and this ties together individual exhibitors in these Courts. We saw, for instance, Australia Court with Amalgamated Wireless (A'sia) Ltd. and Electric Control & Engineering Ltd. representing the Electronics section. In the AWA stand variety was provided with displays of domestic radios and Television and in contrast Marine Radio Telephone and solid state power supplies. Electric Control & Engineering showed industrial control equipment, Telscan telemetering, etc. The Australian Court was fully carpeted throughout and quite obviously had a lot of money and effort spent on it as had the other pavilions also. From there to the U.S.A. Court, the second largest after Australia, where the main theme was a central Tower with a realistic looking rocket atop it seemingly ready to blast off any minute. Here Electronics was represented by a well designed and well presented stand of P. H. Rothschild & Co. Ltd. Main feature of the display which was "Heathkit" equipment was a complete Laboratory designed for teaching Scientists or school instruction, etc. Central feature of the stand was a Demonstration Meter with a moving pointer creating public interest. Also on show were various other test equipment, Amateur Radio, Marine, etc.

Our next stop was the Indian Court. This is a new venture for this country and the electronics section was in the form of amplifiers and outdoor speakers, cables and a small electrical display of insulators, etc. India, we were told, wants to establish a market here and is looking for agents. We felt, with respect, that they have to improve the finish quite a lot before the equipment competes with either imported or locally made goods.

From here an attraction was just round the corner. Sony of course. H. W. Clarke Ltd. hit the jackpot with an excellent display of Sony Radios made under license here and the latest tape recorders, one of which will be assembled here soon we were told. Main attraction, however, was a Video recorder. This latest development of the Electronics Industry shows the remarkable advances made by Japan in the past few years and by Sony in particular. So recent in its development a sister unit only arrived at the New York Worlds Fair at the same time as this one did, the recorder showed by its clean appearance and obvious detail, the development that must have gone into its execution. Tapes were shown from overseas of various travel and industrial aspects and judging by the quality of recording the future seems bright in this line.

Moving past the NZBC "Glasshouse" studio/control room where the public could get a "behind the scenes look" at how a Broadcasting station works, we were attracted to the New Zealand Court. This featured N.Z's export drive and we were surprised—pleasantly, we might add—to see electronic equipment being exported. Amongst the displays we saw Pye (N.Z.) Ltd. with VHF Radio Telephones, well made and designed and exported to Australia, Fiji and other places. Another attraction here was the All Sky Camera. This completely New Zealand invention and development by D.S.I.R. scientists combines optics and electronics to best advantage in producing a unit which has found a ready (12 so far at £1,800) market in various countries including U.S.A., Sweden, etc. — made under license by A. F. Harding & Co. who also show a metal locator and various other electronic equipment for export. Next door we found the Republic of China, Taiwan. This is another country trying to get into the New Zealand market and their contribution consisted of some transistor radios (not as good a quality as the Japanese), cable which seemed to be well made and some electric appliances.

National Electrical & Engineering were represented in at least two courts. On the U.S.A. Court with motors and on the Australian Court with micro-switches and signal lights these being of particular interest to designers of industrial and other equipment. Communication Systems (N.Z.) Ltd. had a variety display of some of their many well-known lines. Outstanding amongst them was a telephone system incorporating codecalling, dictating facilities, radio telephone hookup facilities, etc. In fact this telephone system does everything. Most versatile idea we have seen for a long time and one which should find plenty of interest particularly in larger offices. Also displayed was their traffic light systems, dictating machines featuring Philips, Radio Telephones, both MF and VHF, including compact models as fitted to motor cycles.

Our general impression of the Fair was that, unlike the usual run of trade shows, this one was different — startingly different because of the specially imported equipments showing the latest trends from overseas. Different because of the country concept showing our close relationship with the world. Different because of the seemingly much greater effort and expense put into its organisation.

We talked to a great many people both in the Trade and public generally and they all felt as we did that this was worthwhile even if some equipment shown was not readily available, at least it would stimulate local manufacturers into renewed efforts. Those of you who saw it, we feel sure enjoyed it. Those of you who missed it, well you missed a good show. Try to make it for the next one.

ENQUIRY CARD AD. 13

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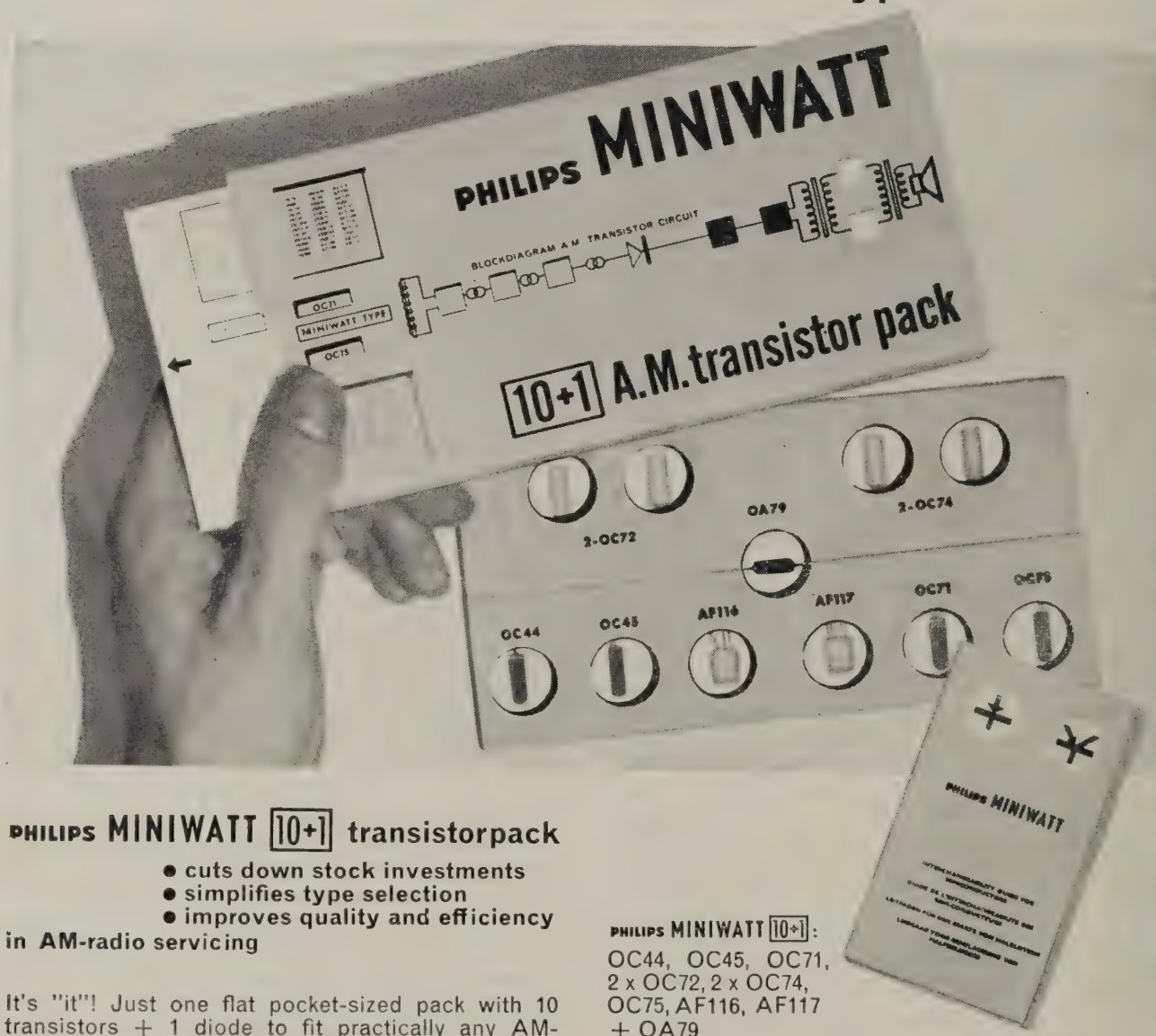

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Problems and Prospects For Communications Satellite Systems

*by G. K. PARDOE**

One of the most interesting applications of Space technology has been the work on communication satellites. This idea was first proposed in 1945 by a British engineer who suggested that instead of using the rather uncertain natural ionosphere as a means of reflecting radio signals from one point on Earth to another, a satellite could be used for this purpose. Two different types of satellites could be visualised, one essentially passive—to act as a pure reflector from which the radio signals would be bounced back towards Earth—and another type which would be active, containing electrically powered receiving and transmitting equipment to achieve the same purpose. Both types have interesting applications but the advantage would appear to lie very much with the active satellite because it is more powerful and flexible in operation. Most of the interest in the world at present is therefore centred on this type of satellite for civil communication purposes, even though military interests still involve various forms of passive satellite reflectors.

The advantage of a satellite is that while the ionosphere is subject to severe disturbances in its role as a reflector (owing to sunspot activity and other electrical phenomena), a satellite, when used as a relay, will maintain high-quality signals without such susceptibility to natural interference. The satellite is, however, required to operate far from Earth in a difficult environment of high and low temperatures, vacuum conditions and radioactivity—to mention but a few. It is also required to last several years if it is to be an economical proposition, in view of the high cost of launching the satellite system and the fact that at present no servicing is, of course, possible.

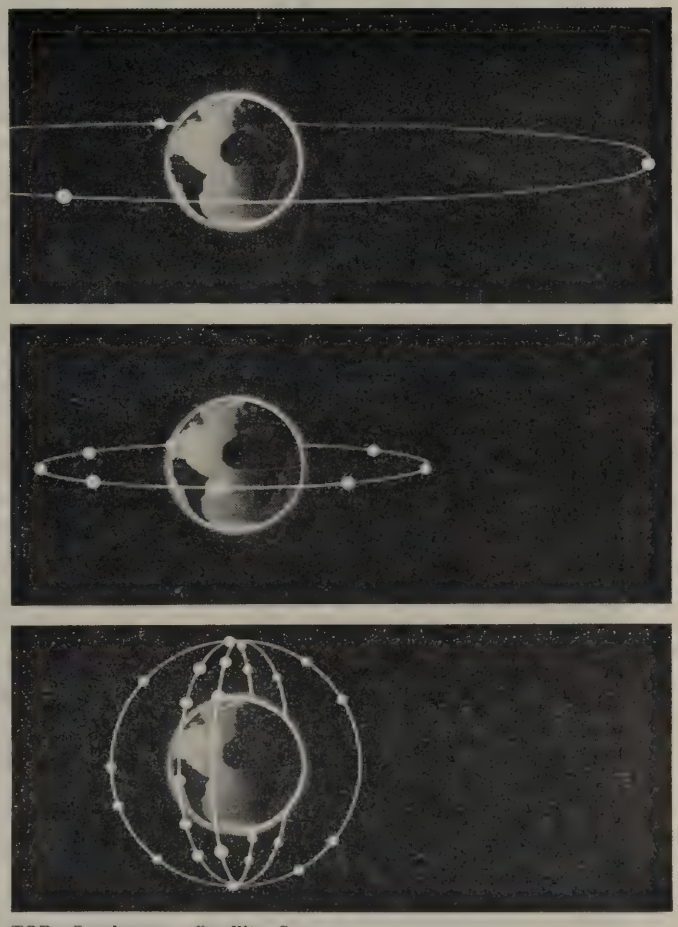
To take the greatest advantage of the electrical power that can be made available in a satellite it is desirable to use high-gain directional aerials for transmitting and receiving. To achieve this it is necessary to stabilise the attitude of the satellite to an accuracy of a degree of two of angle with respect to Earth. Obviously this attitude stabilisation system must be very reliable and must also have a life expectancy of several years.

In some types of system the satellite will be allowed to drift in a random position relative to others in the same orbit, but in most cases the satellite is required to keep station with its neighbour. This requires a system of small rocket jets which can be turned on and off to maintain the position of the satellite, and will be integrated in some respects with the attitude stabilisation systems.

The problems mentioned so far relate to the satellite once it is established in orbit. Before this, of course, there is the difficult phase in which the satellite is launched and accelerated into the required orbit. Bearing in mind the need to keep station, it is clear that this "injection phase" must be carried out with considerable precision and so, in addition to the basic problem of lifting a certain weight of satellite into orbit, there is the problem of accurate navigation up to the point that the satellite system takes over.

Orbits of Various Kinds

Various types of orbits are being considered; perhaps the most interesting one is a circular orbit 22,300 miles above Earth in the plane of the Equator. At this height the satellite rotates once around Earth in exactly 24 hours and therefore remains effectively above the same point on the Equator, being termed "synchronous" or "stationary." This has considerable convenience, as its fixed position relative to Earth simplifies the ground transmitting and receiving aerials which do not have to track each satellite as it moves across the sky. Moreover, at this altitude three satellite locations, equally spaced around the world, would cover the globe with the exception of the poles. At lower altitudes



TOP: Synchronous Satellite System.

Probably an ideal instance, in which the satellite is established in a circular orbit 22,300 miles above Earth in the plane of the Equator. At this height the satellite's speed is synchronised with the rotation of Earth and would therefore appear to an observer to be stationary. Ground equipment is relatively simple but there are serious problems in launching and guiding the satellite into orbit. The delay between transmitting and receiving speech invoked by the distance the signal must travel from one ground station to another by way of the satellite may preclude the use of this system for very long-distance calls requiring two satellite links in tandem.

CENTRE: Medium Altitude System.

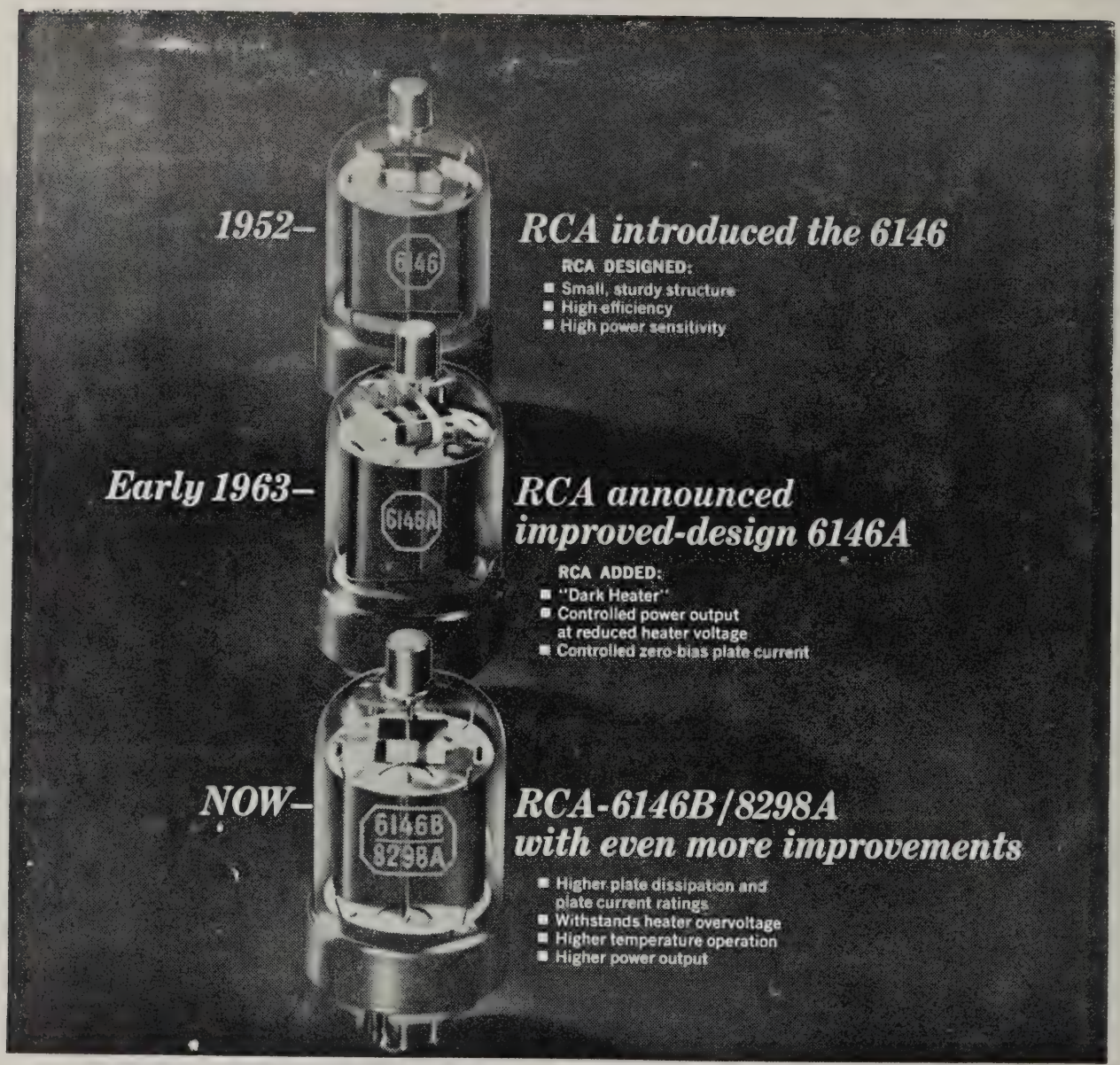
An effective compromise between the synchronous and the random systems. Typically, satellites are established in orbits at about 8,500 miles above Earth, they are spaced at even intervals in a circular orbit in the plane of the Equator, and maintain their relative positions throughout their life. Every satellite would appear to pass over a given point on the Equator once in every twelve hours. Nine or twelve such satellites would provide a continuous round-the-world service, with the use of steerable aerials at ground stations.

BOTTOM: Random Satellite System.

Random low-altitude systems can take advantage of relatively simple satellites. Typically, such a system employs many satellites in a number of circular polar (or near polar) orbits at heights of 4,000 to 5,000 miles above Earth. The system is random in the sense that the gaps between satellites are not controllable—owing to drifting—but the gaps are nevertheless predictable and an increase in the number of satellites decreases the frequency of service interruptions. Advantages are that satellite failures bring only gradual degradation of service, and orbital injection techniques are relatively simple.

* Chairman of the Technical Committee, British Space Development Company, and Chief Project Engineer, Space Projects Division, Hawker Siddeley Dynamics Ltd.

ENQUIRY CARD AD. 14



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the field of view would be less and more satellites would be required.

However, this synchronous altitude is high and requires a large amount of rocket power, particularly in view of the fact that, as yet, there is no launching site on the Equator, and a launch from any other latitude requires not only that the plane of orbit be changed in flight but also considerable additional power. The guidance problem is also acute as final velocities to a few feet per second (metres per second) are required in a total of over 10,000 feet per second.

A further problem arises in the fact that a typical path length of a radio signal travelling from a ground transmitter to the satellite and back again to Earth (one "hop") is in the order of 50,000 miles. Radio signals and hence speech take about a quarter of a second to travel this distance, which is a significant delay in a two-way conversation. Whilst a single hop may be acceptable, it may not be acceptable for two or more hops, and so full world coverage by such a satellite may not be possible for the **telephone** traffic—which may have to be restricted within each single zone covered by one satellite. However, such a synchronous satellite is admirable for all one-way traffic—television, telex, telegraph, data transmission and the like, and there is no doubt that this system will be used to a great extent.

Meanwhile, lower orbit heights are being considered; one such type would have the satellites at about 8,500 miles above the Equator in a ring of nine or twelve, and these would provide continuous coverage between ground stations up to high latitudes both north and south. Another type being given careful consideration (particularly in the United States of America) is one in which the satellites move in polar orbits—that is to say, the orbit is in the plane of the poles. Both station keeping and random position satellites are being considered here, and, in the case of the latter, as many as 40 or 50 satellites would be needed to ensure the necessary high probability of maintaining a constant service. In these lower orbit cases, several tracking aerials of between 50 feet and 85 feet diameter are required at each site to maintain continuity between the satellites and the associated zones of coverage of Earth.

Exact Cost of Satellite Network

It is yet by no means clear which of these systems will be brought into full-scale operation and so there still exists uncertainty on the exact cost of establishing a world telecommunication network with satellites. However, a considerable amount of experimental work is being done to establish evidence to assist in making such a choice. Various well-known U.S.A. communication satellites, such as Telstar, Relay and Syncom, have been launched. Telstar and Relay were placed into low-altitude elliptical orbits designed to give preferential coverage to the North Atlantic, and so enable a variety of experimental transmissions of television and telephone signals to be relayed between Europe and America. These excellent demonstrations of ability really brought the attention of the world, for the first time, to the exciting prospects that exist with such satellites. Syncom was launched up to the synchronous altitude but into an inclined orbit, not in the true Equatorial plane; it did, nevertheless, demonstrate—for the first time—the particular features associated with this "stationary" satellite. Tests between Europe, Africa and America were carried out with Syncom, and improved versions are due to be launched.

Feasibility of Satellite Communications

Sufficient evidence has been obtained to establish beyond any doubt that such communication by satellites is feasible, and data are now being accumulated from these experiments on the problems of attitude stabilisation, radio power requirements and so on. The initiative for such work is, undoubtedly, with the Communication Satellite Corporation of America, which has been formed as a private company, with U.S.A. Government backing, to arrange for the development and operation of a world network under the sponsorship of the U.S.A. To this end, the U.S.A. is arranging for more experimental work to be done with satellites, and in 1965 expects to put into synchronous altitude a satellite which will not only be experimental but could subsequently produce an operational capability. The U.S.A. expects that its main system will have been chosen by the Autumn of 1964, which will enable the full worldwide coverage to be achieved by 1966 or 1967.

European Role

Where does the European interest lie in these matters? Conferences have been held in Europe between government representatives through 1963 and into 1964 and these followed earlier discussions between the various national postal and telephone authorities. From these discussions it would appear that the European Governments are anxious in principle to participate in a global network of communication circuits, using satellites. In many European countries a strong determination exists that Europe should not only participate in the transmitting and sending of signals by way of ground stations in a world network of U.S.A. ownership, but that the European nations should also participate in the management of the system, should use European launching rockets and sites, and develop and build some of the satellites that would be used.

It is recognised that the U.S.A. has a significant lead over Europe in its experience of Space technology. However, European countries—particularly Britain—have a great investment and experience of worldwide telecommunication facilities and operations, and in view of this, and the extensive interests and needs of European countries to expand networks around the world, Europe **must** retain a strong participation in such a system—which should not become the monopoly of one country alone. It remains to be seen what basis of collaboration is established between the European Governments and the U.S.A., which has already proposed that Europe should join as a junior partner in the American sponsored system. It is to be hoped that full European participation, in the sense described above, is finally agreed.

The role that the three-stage rocket vehicle being developed by the European Launcher Development Organisation (ELDO) would play in these matters is now obvious. This large satellite launcher is essential to place a reasonable size of communication satellite in orbit to meet civil telecommunication needs, and agreements that Europe would play a part in launching such satellites would establish a very important requirement for the use of the ELDO vehicle. At present, it is expected that the vehicle will launch research satellites for the European Space Research Organisation (ESRO), but these new communication satellite requirements would ensure that the ELDO rocket was suitably designed for this important purpose, and that it could lead to an improved performance which may be necessary to meet later communication satellite requirements.

Effect On Cable Policy

It is now generally recognised that communication satellites will provide vital extensions to the existing telecomcunication systems around the world. In a report the American Telephone and Telegraph Company recently announced that it would not now lay a new 720-channel submarine cable across the Atlantic, but will rely on communication satellites to provide such added capacity. Further cables will undoubtedly be laid in various parts of the world as the need becomes clarified, and indeed cables and satellites will provide a complementary service.

The important starting point for designing any satellite system is to establish the telecommunication traffic demand around the world, which will then subsequently define the system to meet it. The cost of developing and deploying a satellite system is high—depending on the system, it could be in the order of £100,000,000. However, estimates have been made, which show that over the first 20 years of operation the revenue from the system would exceed the development and operational costs by several times this amount. Exactly when full world coverage by satellite systems becomes the generally accepted practice remains to be seen, but there is no doubt that the subject of communication satellites is rightly demanding great attention at the moment, and will be one of the most important applications of Space technology.

Making The Most Of TECHNICAL PERIODICALS

by E. R. EASTEAL

In spite of recent advances that have been made in the field of mechanized information retrieval there is still a need for the engineer to enquire on his own behalf into scientific literature in order to make the most effective use of his available sources of information. To do this thoroughly, he will need to be aware of the variety of information services provided by technical periodicals.

A periodical represents a proper vehicle for the formative approach to current problems where ideas, not fully established, can be discussed at some length; because of this, the information given in it should be the earliest knowledge of a subject in general publication. With the tremendous growth of technical information, speed in transmission is an important element and it is the primary duty of a journal to keep its readers informed of the latest developments in the field. This is by no means easy, because of the tremendous diversity of the material itself and of the long delays which occur between an original research and its general release either as a paper (delivered to an Institution or a Society) or as an article (written for an authoritative commercial journal).

At the present time, literary output in technology is, for many engineers, a largely unmapped jungle through which a path must be cleared if the best is to be made of the latest knowledge. Some inroad may be made into this if an evaluation is made personally by the individual engineer, using the same broad principles of selection that he would choose when buying a book, namely, the reputation of the publisher, the authority of the contributors, the speed with which the information on the latest research and development appears, the typographical matter, the form and layout of its leading article, and the bibliographies, illustrations and charts which amplify the text. All must be examined carefully to find out what the journal is trying to do for its readers. Its ancillary material will also be worth noting, whether it covers meetings and reviews past conferences or mentions those that are forthcoming, whether it reviews new technical books and reports critically, whether it abstracts items from other journals on the same broad subject coverage or whether it is abstracted itself. Its biographical notes on contributors, its obituaries, its notes on new designs, products and research will be taken into account as some of the normal extension activities of a particular periodical because they provide an all-round awareness of the subject field and the personalities connected with it.

An index to the periodical is essential for checking retrospective articles and this should be included separately, or with the last issue of the current volume for binding if required. If a journal is to be considered as having any lasting value for further references, it must contain an adequate index, fully capable of directing the enquirer speedily to the relevant part of the volume. This requires care to ensure that there is a distinctive pagination to allow for the possible exclusion of unnecessary advertising matter. The index itself should be systematically arranged by author, subject and title, covering in full the essential material published in the volume. This means that it should include not only the main articles and shorter notes, but book reviews, obituaries, notes on contributors, conferences, editorials and important illustrations.

Other ancillary items include the provision of a useful trade literature service where readers can not only see the variety of advertising material on view in the journal, but can also take advantage of a request card service for a direct line on manufacturers of the product concerned. Many journals now extend this facility to certain leading articles where such a demand is likely. Some periodicals contain useful bibliographical lists on current topics and occasional translations of foreign articles.

One of the biggest problems in selecting a periodical is to determine the subject level from its articles and the standards set by its editor, since, in addition to the many authors writing for it, each periodical will have its own editorial policy, and therefore an appreciation is needed of each main type of journal.

There are those whose primary intention it is to keep readers informed on current topics by giving a popular account only, with few technical details. They have a secondary function to keep engineers informed of new items of interest that are marginal to their own lines of research. An innovation in recent years has been the highly successful "newspaper" type of periodical which publishes, weekly, brief information for industry in an easily assimilated tabloid format rather similar to a

* Deputy Technical Librarian, The Marconi Company Ltd., Baddow Research Laboratories, Gt. Baddow, Essex, England.

popular "daily." These give not only a few medium-length articles but also print items which could not achieve publication in their own right because of their extreme specialization or limited appeal.

Although a trade journal is primarily produced to represent a trade, it may not be published by an association but only be sponsored by one, and a wider circulation is maintained by commercial distribution, unlike the restrictions imposed on sales by a learned society or professional body. A balance is achieved between working practice methods and new developments for engineers on the shop floor. Allied to these are the numerous technical periodicals which serve a wide field, giving brief notes on current developments in production and research as well as substantial articles on techniques. As the main intention of these journals is to reach as wide a public as possible, they will attempt, at all costs, to keep each article lively and fresh. They will, in addition, give a number of special services, from the forwarding of requests for trade literature on manufacturers' products to the answering of individual problems on subjects promoted by the journal, either by a personal reply to the enquirer or through the medium of its columns. This type of journal is by far the largest group and covers not only important technical periodicals of well-known commercial publishers but also includes journals issued by large companies, whose motives in publishing are to place before informed engineers and research workers, at a high technical level, the work of the company and its staff, selling themselves through the medium of a well-produced "prestige" publication.

For advanced work, those periodicals published by a learned society or an institution are often of most value, especially when, through their columns, an original piece of research first becomes public. In addition to articles of substantial length, often on highly specialized work, these journals will report, in the form of shorter notes, on topics of extreme specialization and limited appeal which would not normally be published in full elsewhere. Usually these journals are restricted to members of the organization concerned and, like the publications of Universities and Colleges, there is no primary intention to make a profit. Some academic publishers also produce commercial periodicals of very high calibre under the editorship of an international editorial panel of specialists and little or no profit is made on some of these. This is not to imply that there is anything wrong with the profit motive or that it diminishes the high standard of technical publication which exists in the scientific field. The main difference between a commercial journal and the publication of a learned society is usually less in the article itself than in the degree of specialization to which an editor is prepared to admit. In this category, some book reviews, references to other material on the subject, illustrations, charts, tables and bibliographies will be given.

Governments have long interested themselves in the periodical field as a ready means of passing on information which they have acquired through their research laboratories and study groups. They have the opportunity, as large publishers, to know from experience the demands and the probable intellectual levels of their readers. They can therefore aim to provide, at a low cost, informed technical journals for groups of scientists and engineers working in a limited subject field. Such is the diversity of the activities of Government departments today that many technical subjects of extreme importance to industry are covered by them through their periodicals. International organizations also produce fine specialized technical journals like those of The International Telecommunications Union, or on a variety of subjects as in the case of the United Nations Organization.

Finding out about foreign periodicals is a problem because comparatively few public libraries take them into stock and use them. Government and special libraries are becoming more aware of their value and, by co-operation, the foreign journals are easier to see and are better known. It is important for the user to have a reasonable knowledge of languages, especially in the use of foreign technical terms, as well as a good knowledge of his subject because, in spite of some useful abstracting into English by the best foreign journals, it is still important to be able to follow closely the abbreviations and technical jargon. A survey by the Department of Scientific and Industrial Research indicated that only 2% of British scientists claimed a working knowledge of Russian whilst 60% and 80% were claimed respectively for German and French. To counter these shortcomings a large programme of translations of Russian journals has been inaugurated and has partially closed the gap in this respect.

As in the case of English and American journals, there is no organized evaluation of continental periodicals and, for the best coverage of a subject, it is usually the publications of a learned society that are the most authoritative. The best way to obtain an evaluation of a commercially produced foreign periodical is to see how long the journal has been covering the subject under review or, alternatively, to check how many times the journal has been cited as a reference over a given period by a reputable abstracting journal.

Some journals, popular for a few weeks only, have little or no lasting value and after perusal can be discarded immediately or filed for a limited time only. Academic periodicals have little popular appeal but the value of their articles is greater and will be more evenly spread over the years following their publication and will therefore be filed permanently for reference by individuals and libraries specializing in the subject. As they are of a continuous nature, they are superior to books because history and topic fluctuations can be reviewed continuously from their beginnings up to the present time and a picture of the original work and subsequent development built up. To overcome the limitations that long runs of these impose,

(Continued on page 37)

ENQUIRY CARD AD. 15

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R98 T.V. POWER TRANSFORMER

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230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

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On Our Bookshelf . . .

The first book this month is entitled "**Transistor Electronics in Instrument Technology.**" Edited by N. I. Chistyakov, Translated from the Russian by G. R. Kiss and Published by Pergamon Press.

This book is a collection of technical papers on various aspects of the use of semi-conductors in instrumentation. These and others were read at a Scientific and Technical Conference organised in Moscow in December 1956 by the Scientific and Technical Society. Now, some eight years later, this work has been translated and published. The original Russian text was published in 1959. This is, of course, the reason why today some of the techniques seem to be commonplace, whereas, in fact, when these papers were first read they were relatively fresh and original concepts.

Some of the articles make excellent reading. Papers such as "Some Properties of Emitter Follower Circuits," by V. I. Lebedev, describing work done on Emitter Followers in various applications and "Thermal Stabilization of Transistor Pulse Circuits," by V. P. Nechayev, which discusses a Transistorised "Kipp-relay" or Triggered Astable Multivibrator, are particularly interesting. It seems apparent from some of these papers that high frequency transistors were not freely available at the time of writing as there is reference to the maximum frequency of operation of transistors as being below 1 megacycle. However, some of the articles portray both P.N.P. and N.P.N. types of transistors. Another surprising feature is the inclusion of a pair of articles, one quite lengthy, on techniques employing point-contact transistors, a device little used because of its limitations. However, two other articles on transistor oscillators (the second one, in particular, on high stability crystal oscillators) show a thorough understanding of the design problems for such service.

The final third of the book outlines some of the commercial and industrial applications to which transistors were considered applicable at that time. For example, "A.C. Servo Systems with Transistors and Magnetic Amplifiers," by N. I. Chicherin, and "Telemechanical System of Despatcher Supervision and Control for Mines Using Ferro-electric Ceramic Non-Linear Capacitors and Semi-conductor Devices," by B. V. Kol'tsov. Both make interesting reading in that they portend future advances in automation.

The text is easy to read, but perhaps this is a tribute to the translator, and there are copious drawings, circuits and other explanatory blocks.

Our copy by courtesy of the Publisher.

The second book this month is entitled "**Amateur Radio Antenna Handbook,**" by H. D. Hooton W6TYH, and published by Howard W. Sams and Co. Inc.

Here is a useful text for the amateur who is interested in designing or contructing an antenna. Whether contemplating a lofty tower with multiband beams or a simple "dipole" sky-wire supported between two chimney stacks, this book carries a lot of useful information.

The first two chapters deal with Fundamentals of Radio Wave Propagation, and Antennas. Chapter 3 discusses various types of antennas from the dipole to the quad; from the rhombic to the groundplane. Chapters 4, 5 and 6 can be taken together in that they discuss Transmission or "Feed" lines, matching systems, and Transmitter coupling systems. Chapter 7 details practical construction of beam antennas, and includes short notes on some of the commercially manufactured arrays, discusses at short length some V.H.F. and mobile antennas and gives way to Chapter 8 where 14 pages are devoted mainly to commercial types of tilt over towers. There are a number of tables included which would be of use to anyone contemplating the construction of their own "sky hook."

Whilst the first section of the book gives good coverage of the techniques and problems, it is felt that the last two or three chapters tend to be a little skimpy. For example, there were only two pages devoted to the subject of vehicular antenna systems, both for medium frequency and also V.H.F. operation.

The text is generously supported by drawings, figures and tables, and the only mathematics used is simple arithmetic for calculating element lengths, etc. In all this book will prove a welcome addition to the amateur's library.

Our copy from Technical Books Ltd.

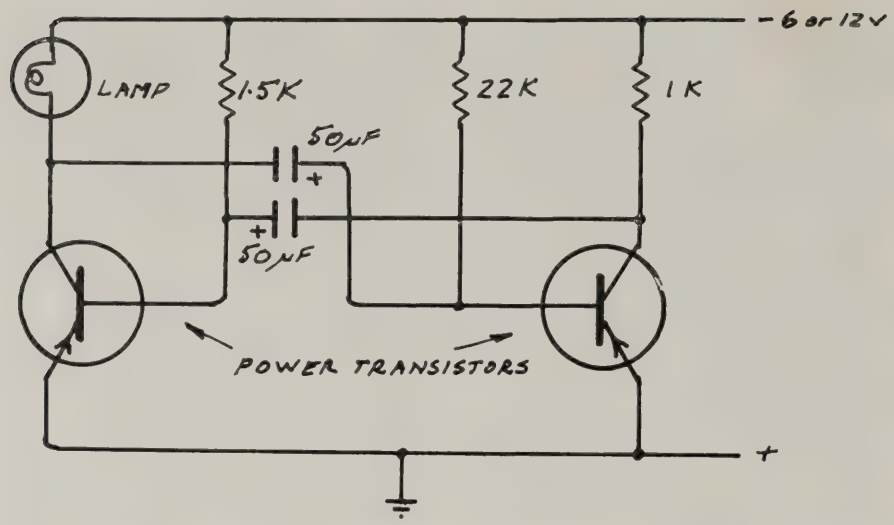
"**Test Equipment Maintenance Handbook,**" by Robert G. Middleton. Published by Howard W. Sams & Co. Inc. 160 pp. American price $2.95.

Robert G. Middleton, who will be known to many as the author of the "101 Ways" series of books written primarily for electronic technicians, has this time turned his attention to "testing test instrumens." However, it should not be imagined from the title that the book deals only with the upkeep of test equipment as the subject is treated in a manner which enables the reader to gain a fuller understanding of the nature and function of the various items dealt with.

A chapter is devoted to each of the following: Volt-Ohm-Milliammeters, Vacuum Tube Voltmeters, Audio Oscillators and Square Ware Generators, R.F. Signal Generators, Colour Generators, Oscilloscopes and Valve, Transistor and C.R.T. Testers.

Each instrument is dealt with in a thorough-going manner and includes information for checking calibration. In the case of VOMs and VTVMs use is made of a mercury cell a source of calibrating voltage which should be

(Continued on page 40)



Transistorised Lamp Flasher

The use of transistors in high voltage flashing neon type warning signals is familiar to many readers but not so much detail has been published on low voltage flashing units and electro mechanical means are still the most popular method of flashing, say, a 12 volt, 6 watt automobile type lamp.

The unit described was developed as a source of flashing power for hospital patients — call systems. In such use quietness of operation is essential and other factors such as low current consumption and cost are not so important. Solid state switches are considerably quieter and more reliable than the charged capacitor and relay type of flash timing sometimes used in such situations. An additional feature is that no radio interference is radiated.

Whilst the original circuit was developed for 24 volt operation it is thought that 6v or 12v is more likely to be the supply preferred by the home constructor. Positive earth is shown to suit most automobile supplies. There is no reason why the negative line could not be earthed and the positive "up in the air." Whatever polarity is chosen the case of the transistors, as the collector, will need to be insulated.

The values shown in the circuit give a flashing rate of about 1 per second. Larger capacitors will give a longer period.

The transistor types shown in the circuit are audio power types capable of handling a collector current in excess of 1 amp. However, to obviate the need for large heat sinks the value of the lamp used should limit the current to about .5A. At this value a heat sink of 2 sq. inches per transistor appears adequate. In the 12 volt prototype a lamp taking 300 mA was used and the transistors were operated **without** heat sinks. If a metal case having one side of at least 12 sq. inches is used as a cabinet (or the same area as a heat sink without a cabinet) and the transistors mounted thereon probably 1 amp. loads could be used. As ambient temperature and the pulse rate come into the question of operating temperatures careful trial and error (we hope there will be no error!) will produce the maximum wattage lamp value that can be used. Do not run the transistor above a safe case temperature — one that is comfortable to the palm of your hand held on the transistor for 10 seconds is usually safe.

Transistor Types

The circuit is not critical as to types or characteristics of transistors and the following types have been found suitable:

for 6v operation — Philips OL30 or ASZ16 or RCA 2N301.

for 12v operation — Philips ASZ16 or RCA 2N301.

The 50 μF capacitors should be 50 volt types for low leakage.

Work is at present being done to determine the requirements needed to replace the lamp with a relay for heavier current loads. The inductive effects of the relay coil cannot be overlooked and, at present, it is not recommended that the lamp be simply replaced by a relay.

Imported Instruments on Display

A display of instruments staged by W. and K. McLean Ltd. has recently visited the main centres with the terminal display in Auckland during September visited by this publication.

The exhibitors represent a number of overseas companies — the most important ones, from the display point of view, being Tektronix Inc. of U.S.A., General Radio Company of U.S.A., Airmec Ltd. of Great Britain, and A.E.G. of Germany.

Of particular interest was the new Tektronix oscilloscope with a flat face 5in. ceramic cathode ray tube with internal graticule. Such a feature obviates all error due to parallax. A.E.G. semiconductors were well to the fore and a most interesting item was a cutaway section of a large rectifier showing the actual junction. General Radio was well represented with instruments ranging from precision capacitors to counters and sound level meters. The British firm of Airmec's items did not especially impress our reviewer. Whilst the equipment shown undoubtedly performs well, appearance leaves something to be desired. Perhaps the "modern" forms of Tektronix construction and even modernisation by G.R. showed Airmec off to a disadvantage. It does, however, indicate how important is appearance **combined with** performance.

W. & K. McLean provided plenty of literature to support their efforts. All together, a good effort which we hope other companies will follow. There have been two such exhibitions recently and as both exhibitions report increased interest it is obvious the effort pays off. — W.L.

TECHNICAL PERIODICALS

—Continued from page 33

microfilms are being purchased increasingly by libraries to keep down storage costs, in spite of a feeling many have that the microfilm and its associated equipment is yet another barrier in the communications path of the research worker.

As knowledge increases, so each item tends to become more specialized and this, in turn, leads to an increasing number of publications to cope with the growth. It is the concern of everyone in the field of information retrieval, from the initiators, the authors and publishers to the librarians who will use and present the material for readers, that knowledge, once acquired, is not allowed to go by default into the depths of the library archives or on to the nearest scrap heap.

E. R. EASTEAL
The Marconi Company Limited, England.

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RECORD REVIEWS

BACH: Goldberg Variations, Helmut Walcha, Harpsichord. Record Society Edition.

In an interesting note on the record sleeve, Helmut Walcha sets out three principles which were "foremost in his mind" as he recorded this disc; an inner spiritual peace, simplicity of performance and clarity. I first listened to this recording without having read the sleeve—my usual practice, as there is seldom much of interest thereon. I thought it rather dull, the registration uninteresting and the rhythm unyielding. I then replayed it keeping in mind Walcha's "three principles," and I must admit that I found a lot to admire, the second time through.

There is no doubt more to these variations than meets the ear at first hearing, and I would recommend this desc to music lovers who want to come closer to J. S. Bach. As time passes he increases in stature as a composer, as scholars such as Walcha endeavour to present his works as the composer intended. The average music-lover will probably find four sides of harpsichord music rather a strain and might rather spend his money on two other discs of greater immediate interest.

The performance is technically excellent with plenty of life in the tone of the instrument.

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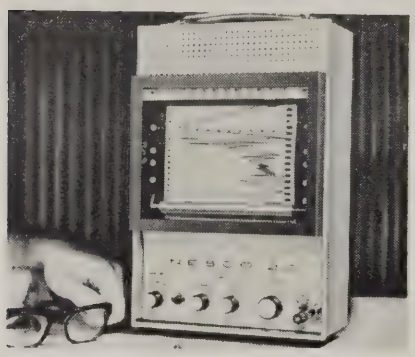


NEW NESCO TRANSISTORIZED RECORDER

Epitaxial planar silicon transistors for low noise and stable operation from 0 to 55°C, nine ranges from 1 mv to 10 v, adjustable zero control, 1/2% accuracy, automatic take-up reel, and capillary pen are features of the new NESCO 210 Transistorized Chart Recorder.

Features include full span response (max. pen traverse speed) of 0.4 second, positioning of zero any place on chart or up to ±50% off chart by panel control, and choice of any two of sixteen available chart speeds. Calibrated chart width is 5 inches. The unit is designed for easy portability and may be operated in horizontal or vertical position.

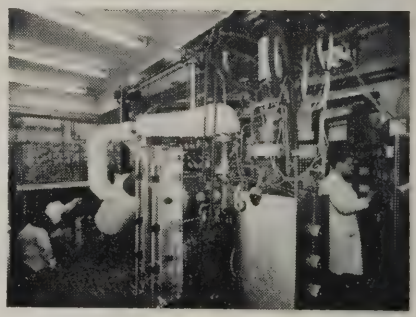
Excessive ink flow or bleeding at slow chart speeds, a defect of many recorders, is eliminated through the use of a proven capillary pen system. Remote ink reservoir has capacity for 90,000 trace-inches. Ink supply is easily replaced with sealed ink cartridge. Chart unwound for review is automatically re-rolled. Clear plastic chart cover may be removed for chart notation. Sensitivity is less than 0.5% of scale span. Precision tuned line frequency notch filter minimizes response to longitudinal or transverse common mode signals.

ENQUIRY CARD 44

* * *

BRITAIN'S WORLD LEAD WITH "MPD" ELECTRIC POWER GENERATION

This complicated apparatus in a Newcastle Upon Tyne, England, laboratory is the world's first "closed cycle MPD" — or magneto-plasma-dynamic electric power generator. The only moving part is a high temperature gas, which is forced through a magnetic field to produce electricity. More power is generated from the same amount of fuel because the temperature requirements of the closed cycle system are lower.



MPD has been developed after three years' intensive research by Britain's International Research and Development Company. It operates with a mixture of pure helium and cesium, which is compressed and passed through a heat exchanger to a graphite electrical heater—simulating a nuclear reactor core—that produces gas temperatures up to 2200 degrees Centigrade. The plasma then passes through the MPD generator at a high velocity.

Possible future applications of the closed cycle MPD generator are envisaged in ship and submarine propulsion, large space satellite and planetary stations and in interplanetary vehicles.

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OCTOBER, 1964

NEW COMPACT SURVIVAL RADIO FOR LIFEBOATS

A new portable radio, claimed to be much smaller and easier to operate than previous types, has been developed for use in ships' lifeboats by a British company.

The first of its kind to be completely transistorised, the set, known as the Solas 11, weighs less than 30 pounds, can be operated by one man, and transmits and receives on three different frequencies.

The set floats and can be thrown overboard in an emergency and later retrieved from the sea when survival craft have been manned. Built to withstand a drop of 30 feet into the water, it has a 30-foot nylon heaving line attached. The set is normally strapped to the operator when in use, leaving both hands free to operate the equipment.

Power is supplied by a built-in hand generator, but a single dry 16.5-volt battery may be used instead.

The new set has been designed to conform to the new requirements of the Merchant Shipping (Radio) Rules that will come into force in 1965.

ENQUIRY CARD 47

INDUSTRIAL LAMINATES FOR COMMUNICATIONS

A strong trend noticed at the recent International Instruments, Electronics and Automation Exhibition in London was the almost universal adoption of printed circuits; not only in mass-produced goods such as radio and television receivers, but also in short-run specialist instruments and scientific equipment. Several manufacturers of industrial laminates were exhibiting, amongst them **FORMICA Ltd.**, who had a particularly interesting display of current equipment using their materials.

Process Control Equipment

For their new range of Transdata unitized electronic process control equipment, **George Kent Ltd.** have adopted FORMICA CGE 70 copper-clad laminate for all printed-circuit boards. Made from continuous filament glass fibre bonded with a special epoxy resin, this laminate is characterised by good retention of mechanical strength at elevated temperatures and high bond strength between copper foil and glass/epoxy board even after thermal shock. This is particularly useful when soldering has to be carried out after final assembly—in servicing, for example.

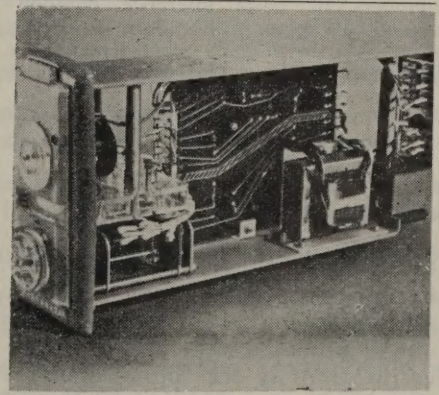

FIG. 1 — An auto-manual, desired-value station from the Kent "Transdata" range of unitized process control equipment. It uses a printed circuit card made of FORMICA CGE70 glass/epoxy copper-clad laminate. Connections are hand soldered.

The laminate is also especially suitable for plating with precious metals. It may be punched cold in thicknesses up to 0,062 inch, but cutting is best done by an abrasive disc rather than by guillotine. The material conforms to American specification NEMA LP-1959 Type G11 and also to Type G.E.C.D. of the draft British Standard for copper-clad laminates.

Another instrument shown using this grade of laminate was a camera control unit for the Marconi Mk IV image orthicon television camera.

Communications

For the latest addition to their range of "Clearcall" portable transistorised personal communication equipment, **Associated Electrical Industries Limited** have chosen FORMICA DCC 20—a copper-clad laminate based on paper bonded with phenolic resins. A special feature of this grade is the anti-tracking surface left after etch-removal of copper. (Tracking is a form of electrical leakage across the surface of an insulator caused by the formation of a conducting path—generally of carbon). In the AE1 transceiver (transmitter/receiver) type FK2TX/M4, used for communication in mines and other heavy industries, there are three main circuit boards printed on FORMICA DCC 20 material.

FIG. 2 — This dip-soldered printed circuit card in FORMICA DCC20 paper/phenolic copper-clad laminate is from an Associated Electrical Industries "Clearcall" transistorised industrial communications equipment. The circular cut-out is for the speaker/microphone.

Another paper/phenolic copper-clad laminate—FORMICA grade FCC2—was seen in Philips' new 23-inch dual-standard model 3152/3 television receiver. Britain has only just started to make the change from 405-lines V.H.F. to 625-lines U.H.F. and for many years sets will be required to receive both systems. A feature of the FCC 2 laminate chosen by Philips for this set is its resistance to hot solder—an average of 30 seconds at 250°C.

New Fire-retardant Laminate

A laminate similar to FCC 2 but having exceptional flame-retarding properties was previewed on the FORMICA stand. It is designated FORMICA FCC 202 and is expected to be in full production shortly. This material is likely to find wide application in television receivers; it is also seen as a useful safety precaution in computers, most of which have to dissipate a great deal of heat.

ENQUIRY CARD 48

NEW PRODUCTS—*Continued*

BRITISH EQUIPMENT ON IONOSPHERE SATELLITE

Equipment designed by two British scientists and installed in the satellite "Ionosphere Explorer-A", which was launched from Point Arguelle, California, recently, is expected to provide important new information about the constitution of the ionosphere. The 97lb. satellite is carrying a mass spectrometer designed by Professor R. L. R. Boyd and Dr. A. P. Wilmore, both of University College, London. It is one of a number of instruments installed in the satellite, whose purpose is to send back information about the upper side of the ionosphere — the layer of ionised gasses surrounding the earth which acts as an "electrified" mirror for long-range radio communications. The function of the mass spectrometer is to measure the concentration and mass of the various types of ions (electrically-charged atoms) of which this portion of the ionosphere is composed. Because of the important role the ionosphere plays in the transmission and reception of radio signals it is important that more should be known about its composition, and the mass spectrometer is designed to provide this detailed information. This latest venture is a repetition of a successful experiment carried out with an earlier satellite, Aeriel I, in 1962. The United States National Aeronautical and Space Administration are carrying out a number of ionospheric experiments with the new satellite, and it was at their invitation that the British mass spectrometer was installed. Dr. Wilmore was at the range to watch the launching of the satellite, which was boosted by a four-stage scout rocket into a circular, near-polar orbit 620 miles high.

ENQUIRY CARD 49

POCKET RADIO FOR BUSMEN

The problem of contacting bus inspectors who are often beyond earshot of their telephones has been solved, it is suggested, by the issue of pocket radio receivers. The radio receivers may be issued to inspectors employed by Leeds City Transport Department, north of England. The receivers will "bleep" when someone is wanted on the telephone. The inspectors can usually be seen from the control room because the department has television cameras mounted at the three main loading points for buses. But, if the traffic is particularly noisy, the inspector cannot hear his telephone. In normal traffic the pocket receivers will emit a quiet "bleep." If the traffic is heavy, the "bleep" will be louder, and if there is an emergency the receiver will sound a series of rapid "bleeps."

ENQUIRY CARD 50

* * *

QUICK STRESS TEST FOR TRANSISTORS

A compact contrifuge which can quickly stress test up to 150 transistors simultaneously has been developed. The design is such that it can be operated by unskilled staff. Only 17ins. high and 10ins. in diameter, with separate control box (10ins. by 10ins. by 6ins.) it costs £309 in Britain.

ENQUIRY CARD 51

* * *

LOW COST DIGITAL VOLTMETER

A low cost digital voltmeter — the design eliminates the necessity for large numbers of close tolerance components — is being produced by a British firm. The instrument enables numerous process variables to be read easily and accurately by unskilled personnel. It is basically a 3-digit voltmeter, suitable for operation on mains input voltages of 100/125 and 200/250 V, 50/60 cycles, A.C. The standard unit has four basic ranges giving full scale readings of 1V, 10V, 100V and 1000V, but its sensitivity is such that it will operate directly from most common types of thermo-couple to provide a discrimination of 0.1 of a degree Centigrade over a range of 0-100 degrees C.

ENQUIRY CARD 52

* * *

ACCURATE RADAR-STYLE MAPS IN SIGHT

Maps of great accuracy and detail are hoped for from a new technique under development by the Royal Radar Establishment, Malvern, Western England. It employs the system called SLR—Sideways Looking Radar. The idea is simple. A transmitting and receiving aerial is mounted along the side of the aircraft so that it "looks" out at right angles to the direction of light. The aerial is slotted and pulses of radio frequency power are fed into one end. They spread out from the slots at a vertical angle determined by the angles of the surfaces of a horn into which the aerial fits. In fact, the aerial looks downwards at a strip of ground which may be 10 miles wide. Returning signals are shown in the form of a trace on a cathode ray tube, varying in brightness according to how much of the aerial power is reflected back. The trace is projected through a lens on to a continuously moving film whose speed is geared to the aircraft. So a detailed map of the strip is produced.

Although the principle is simple, practice is not, and the Royal Radar Establishment has been working on improvements and refinements since the research began in 1950. Recent developments are the use of a smaller cathode ray tube and optical fibres. These are artificially made fibres which transmit light with very little loss or distortion. Bundles of them next to the image on the screen transfer it straight to the film with about one hundred times the efficiency of the lens system. The equipment will now produce maps of great accuracy and detail, although the R.R.E. says that there are still many practical problems to be overcome. By "switching out" the signals used for making maps and using them for reference only, the returning signals from moving objects can be recorded. They are changed in frequency according to the speed of the vehicle over the ground. The result is that the radar can show a virtually blank map as a background with all the moving vehicles in the area displayed on it. Differences in speed down to about one mile an hour have been detected. This system could have applications in traffic control and road planning.

ENQUIRY CARD 53

On Our Bookshelf

— Continued from page 35

well within the accuracy requirements for service work. At the present time mercury cells are not generally available in this country other than as miniature batteries for hearing aids but one of these should be suitable for the purpose.

Calibration of audio oscillators is by using the 440 cps and 4000 cps tone modulation on the American standard frequency transmissions from station WWV. These transmissions, although receivable in this part of the world, will probably be too weak and unreliable for this purpose, although signals from WWVH (Hawaii) may be usable. The above remarks also apply to the calibration of RF signal generators by zero-beating with the six carrier frequencies of WWV.

There are many diagrams including schematics of instruments made by several well known American manufacturers. This book should be a worthwhile acquisition for anyone owning or using any of the instruments dealt with.

—J.W.S.

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ENQUIRY CARD AD. 17

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ENQUIRY CARD AD. 16

UNIQUE!

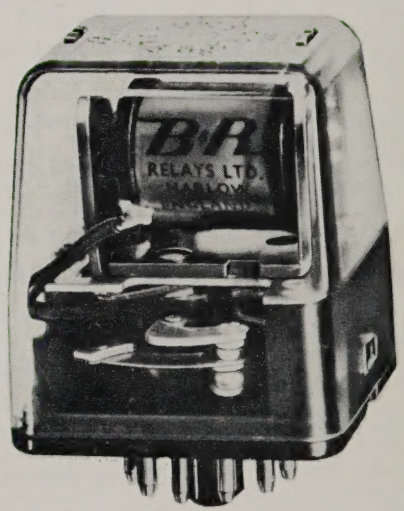
B&R RELAYS LIMITED
Best in Relays

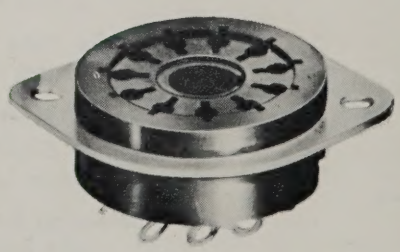
This is the new B. & R. D05/D55 d.c./a.c. Plug-in relay which has three changeover contacts rated at 6 amps. (250 volts A.C. 30 volts D.C. non-inductive).

Specially designed as a plug-in relay, as was the two changeover type D03/D53, the D05/D55 has no flexible soldered connections between contacts and the plug-base and is fitted with a Makrolon snap-on dustcover which has the pin connection diagram embossed upon the top.

The peripherally arranged contacts are each contained in individual pockets, ensuring excellent insulation and clearance between contacts.

The method of actuation ensures that the follow-through is achieved by a rolling action of the contact on making which results in a longer contact life due to the reduction in mechanical wear.





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